PB 202 973

QUAL - I

Simulation Of Water Quality In Streams & Canals

Program Documentation
And
Users Manual

TEXAS WATER DEVELOPMENT BOARD

September 1970

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INFORMATION SERVICE
Springfield, Va. 22151

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102

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA-OWP-TEX-QUAL1	2.	3. Recipient's Accession No.
4. Title and Subtitle QUAL-I Simulation of Water Quality in Streams and Canals Program Documentation and Users Manual			5. Report Date September 1970 6.
7. Author(s) Texas Water Development Board			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Systems Engineering Division Texas Water Development Board P.O. Box 13087, Capitol Station Austin, Texas 78711			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address Systems Engineering Division Texas Water Development Board P.O. Box 13087, Capitol Station Austin, Texas 78711			13. Type of Report & Period Covered Final 14.
15. Supplementary Notes			

16. Abstracts The report documents a mathematical model developed for use in simulating water quality behavior of streams and canals. The spatial and temporal variations of temperature, biochemical oxygen demand, dissolved oxygen, and conservative minerals can be predicted on an hourly basis utilizing the one dimensional form of the advection-diffusion transport equation. The report provides instructions on program usage, input-output descriptions, program description and listing, variable name definitions and flow charts of program logic.

17. Key Words and Document Analysis. 17a. Descriptors

*Mathematical Models
Computerized Simulation

*Rivers
Mathematical predictions
Water Quality predictions

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 13/B and 08/H

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited NTIS U.S. Dept. of Commerce Springfield, Va. 22151	UNCLASSIFIED	103
	20. Security Class (This Page) UNCLASSIFIED	22. Price $3.00/$0.95

Program Documentation

And

User's Manual

SIMULATION
OF
WATER QUALITY
IN
STREAMS AND CANALS
QUAL-I

Prepared
By

Systems Engineering Division
Of The
Texas Water Development Board

September 1970

TABLE OF CONTENTS

	Page
I. QUAL-I General Information	1
Identification	1
Purpose	1
Restrictions	2
Usage	2
II. QUAL-I Program Description	5
Main Program - *QMODEL*	5
Subroutine - *TRIMAT*	5
Subroutine - *SOVMAT*	5
Subroutine - *HYDRAU*	6
Subroutine - *REAERC*	6
Subroutine - *HEATEX*	6
Subroutine - *TEMPS*	6
Subroutine - *BODS*	7
Subroutine - *DOS*	7
Subroutine - *CONSVT*	7
Subroutine - *FLOAUG*	7
Subroutine - *WRPT1*	8
Subroutine - *WRPT2*	8
III. QUAL-I Program Input Data Description	9
IV. QUAL-I Program Output File Description	11
BOD/DO Simulation with Flow Augmentation	12
Temperature Routing	18
Conservative Mineral Routine	25

		Page
V.	QUAL-I Program Listing	31
	Main Program - *QMODEL*	31
	Subroutine - *TRIMAT*	39
	Subroutine - *SOVMAT*	40
	Subroutine - *HYDRAU*	41
	Subroutine - *REAERC*	42
	Subroutine - *HEATEX*	43
	Subroutine - *TEMPS*	45
	Subroutine - *BODS*	46
	Subroutine - *DOS*	47
	Subroutine - *CONSVT*	48
	Subroutine - *FLOAUG*	49
	Subroutine - *WRPT1*	51
	Subroutine - *WRPT2*	42
VI.	QUAL-I Program Variable Descriptions	53
VII.	QUAL-I Flow Charts	59
	Main Program - *QMODEL*	59
	Subroutine - *TRIMAT*	64
	Subroutine - *SOVMAT*	65
	Subroutine - *HYDRAU*	67
	Subroutine - *REAERC*	68
	Subroutine - *HEATEX*	69
	Subroutine - *TEMPS*	72
	Subroutine - *BODS*	73
	Subroutine - *DOS*	74
	Subroutine - *CONSVT*	75

Page

Subroutine - *FLOAUG* 76

Subroutine - *WRPT1* 78

Subroutine - *WRPT2* 79

LIST OF FIGURES

Figure I-1 -- A Schematic Diagram of a Hypothetical Stream System

Figure III-1A -- Input Form A

Figure III-1B -- Input Form B

Figure III-1C -- Input Form C

Figure III-1D -- Input Form D

Figure III-1E -- Input Form E

Figure III-2 -- QUAL-I Input File Description

Figure III-3 -- Input Data Organization

FOREWORD

QUAL-I, documented herein, is one of two programs the Texas Water Development Board has for use in stream quality simulation studies. QUAL-I was developed to simulate the spatial and temporal variations of several specific water quality parameters in streams and canals. These parameters are:

1. Temperature
2. Biochemical Oxygen Demand/ Dissolved Oxygen
3. Conservative Minerals

QUAL-I routes these parameters through a system of streams and canals on an hourly basis. It assumes that the major transport mechanisms, advection and dispersion, are significant only along the main direction of flow (longitudinal axis of the stream or canal). It allows for multiple waste discharges, withdrawals, tributary flows, and incremental runoff. It also has the capability to compute required dilution flows for flow augmentation to meet any prespecified dissolved oxygen level. The basic theory and mechanics behind the development of QUAL-I are described in a Texas Water Development Board Report entitled "Simulation of Water Quality in Streams and Canals."

The other Program, DOSAG, is discussed in a separate report. DOSAG is capable of simulating the spatial variation of BOD/DO in a system of streams and canals. It is not as accurate as QUAL-I, nor is it capable of routing temperature and conservative minerals. However, both programs are needed to properly analyze a complex stream or canal system, and they are to be used in a complementary manner. QUAL-I will be used to study a stream or canal system in great detail under a given condition, whereas DOSAG will be used to analyze this same system in lesser detail but under a large range of conditions.

QUAL-I, as documented herein, is currently operational on the RCA Spectra 70/45, the CDC 6400 and 6600, and the UNIVAC 1108 computers; thus the program is essentially machine independent. The computation time depends on the size of the stream system being analyzed and the number of parameters that are routed. The run time on the RCA Spectra 70/45 for a stream system of 120 river miles through which only BOD/DO is routed is approximately 15 minutes. The run time on the CDC 6400 and the UNIVAC 1108 computers is about 20 times faster than on the RCA Spectra 70/45.

I. QUAL-I GENERAL INFORMATION

IDENTIFICATION

Name: QUAL-I STREAM QUALITY ROUTING MODEL

Code Compatibility:

Computer	Language	Core Required
1. UNIVAC 1108	FORTRAN IV	35K Decimal Words
2. CDC 6400-6600	FORTRAN IV	35K Decimal Words
3. RCA SPECTRA 70/45	FORTRAN IV	35K Decimal Words

Program Written By:

William A. White
P.O. Box 4751
Austin, Texas 78751
April, 1970

PURPOSE

QUAL-I is a set of interrelated quality routing models. The operation of these models produces a time history and spatial distribution of temperature, biochemical oxygen demand/dissolved oxygen (BOD/DO), and as many as three (3) conservative minerals within a one-dimensional, fully-mixed, branching stream or canal system with multiple waste inputs and withdrawals. These models may be operated individually or simultaneously, with one model providing input to the other if such input is required. The user has seven (7) options to choose from:

(1) Route temperature, BOD/DO, and conservative minerals,

(2) Route temperature and BOD/DO,

(3) Route BOD/DO,

(4) Route conservative minerals and temperature,

(5) Route temperature,

(6) Route BOD/DO and conservative minerals, and

(7) Route conservative minerals.

The user has the option to determine flow augmentation requirements based on pre-selected minimum allowable dissolved oxygen concentrations if he so desires.

RESTRICTIONS

The program has the following restrictions:

(1) Maximum Number of Reaches = 25

(2) Maximum Number of Waste Inputs = 25

(3) Maximum Number of Headwaters = 5

(4) Maximum Number of Junctions = 5 , and

(5) Maximum Number of Computational Elements = 500.

USAGE

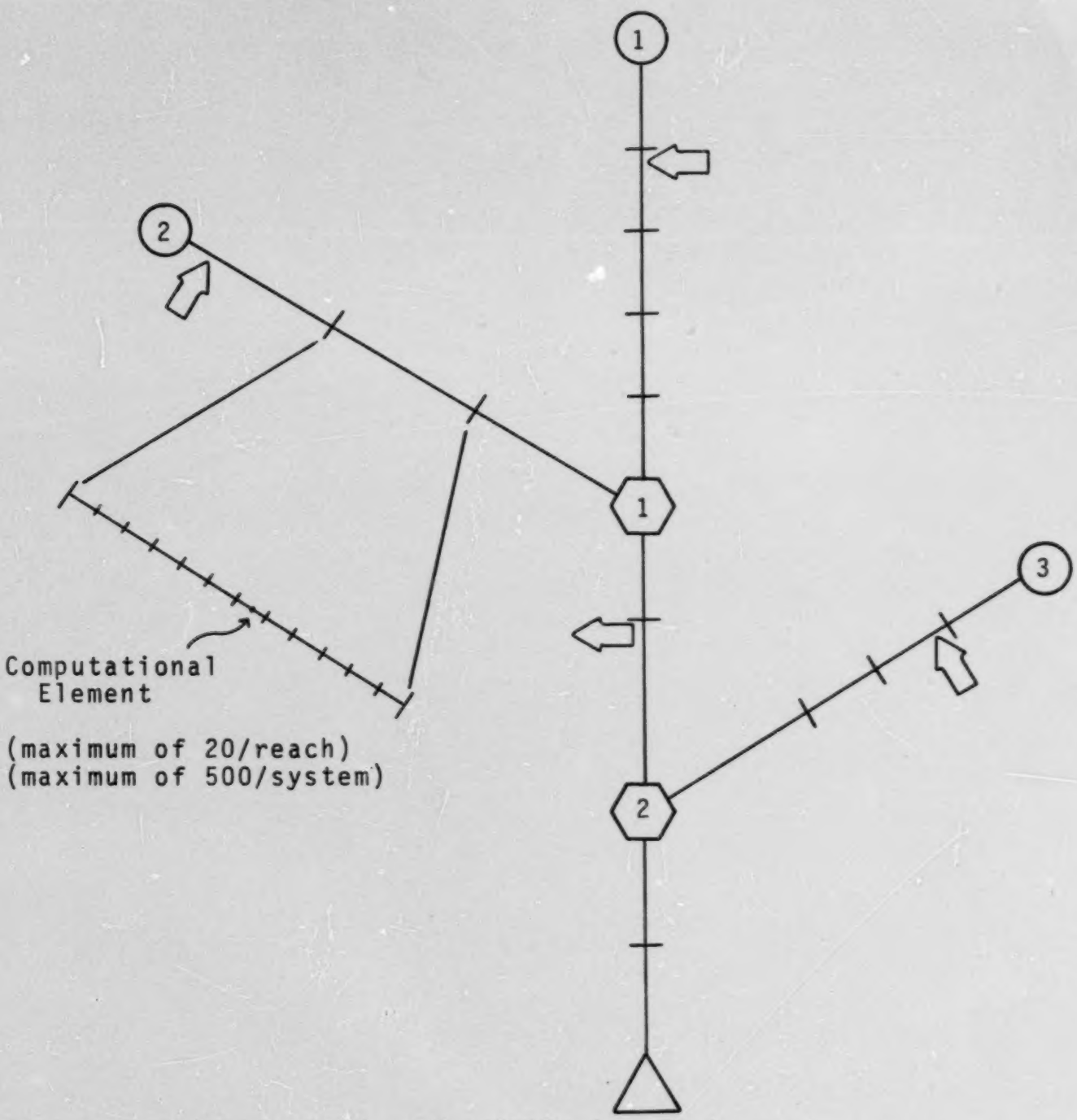
The program is designed to begin the routing calculations from the points farthest upstream (headwaters) of a stream or canal system. As incremental flows and waste inputs or withdrawals are encountered, they are entered into the calculations. The result at the end of the system is a set of simultaneous equations equal in number to the number of computational elements

in the system. This set of equations is solved, thus advancing the solution forward in time. This procedure is repeated until steady-state conditions are reached, which is approximately the time required for a water particle at the uppermost point in the system to reach the end of the system.

The first step in applying the program is to decide exactly which segments of a stream or canal system are to be simulated. A schematic diagram of a stream system is laid out as shown in Figure I-1. The next step is to decide what degree of detail is required. If one is familiar with the prototype system this decision should be fairly easy to make. It should be based on the amount and worth of the available data, changes in stream geometry, and the number and location of waste inputs or withdrawals. Once the amount of detail is decided upon, the stream can be broken down into reaches, which are portions of the stream system with nearly uniform characteristics. Reaches, headwaters, waste discharges or withdrawals, and junctions are ordered sequentially from the uppermost point of the system. This breakdown also determines the amount of data required by the program.

The final step is to decide upon the degree of resolution that is required. Again, this decision should be based on some feeling for how the prototype behaves. For example, if the dissolved oxygen concentration goes from saturated concentration to critical concentration and back to saturated concentration over an interval of about five (5) river miles, a degree of resolution of less

than one (1) mile is appropriate. Once this decision has been made, each reach is then broken down into computational elements or control volumes.



The above basin contains the following features:

- 3 Headwaters (maximum allowable = 5)
- 3 Waste Discharges
- 1 Withdrawal

(maximum allowable = 25)

- 2 Junctions (maximum allowable = 5)
- 16 Reaches (maximum allowable = 25)

FIGURE I-1

A SCHEMATIC DIAGRAM OF A HYPOTHETICAL STREAM SYSTEM

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II. QUAL-I PROGRAM DESCRIPTION

MAIN PROGRAM - *QMODEL*

The main program coordinates a set of interrelated quality routing models and their supporting subroutines. The initial step is to use the reading portion of QUAL-I to read in program titles and problem analysis control data. Then the stream basin configuration, hydrologic, and water quality data are read in. Using this input information the appropriate subroutines are called. QMODEL calls twelve (12) Fortran subroutines.

SUBROUTINE - *TRIMAT*

This subroutine computes and stores the coefficient matrix for the left hand side of the implicit-finite-difference form of the one-dimensional (advection plus dispersion) transport equation (Equation VI-2, Simulation of Water Quality in Streams and Canals, Vol. I, p. 48)

SUBROUTINE - *SOVMAT*

Subroutine SOVMAT solves a system of simultaneous linear equations whose coefficient matrix is of tridiagonal form by using a modified Gaussian Elimination algorithm.

SUBROUTINE - *HYDRAU*

This routine performs a hydrologic balance for a branching stream or canal system based on continuity of flow. It then computes velocities, volumes, and dispersion coefficients for every computational element in the system.

SUBROUTINE - *REAERC*

According to specifications in the input data, REAERC determines the method for obtaining reaeration coefficients. Then it either reads in values for the reaeration coefficients or computes them using a pre-selected equation.

SUBROUTINE - *HEATEX*

This routine computes the net amount of heat radiation flux being transferred across the air-water interface. It is based on an energy budget which considers solar radiation, atmospheric radiation, back radiation, conduction, and evaporation.

SUBROUTINE - *TEMPS*

This routine computes a heat balance for each computational element in the stream or canal system.

SUBROUTINE - *BODS*

BODS computes a biochemical oxygen demand balance for each computational element in the system.

SUBROUTINE - *DOS*

DOS computes a dissolved oxygen balance for each computational element in the system.

SUBROUTINE - *CONSVT*

For each computational element in the system, this routine computes a material balance for as many as three (3) conservative minerals.

SUBROUTINE - *FLOAUG*

After steady-state conditions have been reached, FLOAUG checks the calculated dissolved oxygen concentration against the pre-specified target levels for dissolved oxygen in each reach. If the computed dissolved oxygen is below the target level, the routine then searches all of the upstream headwaters for those sources that the user has specified to have dilution water. Dilution water is then added equally from all sources and calculations are repeated. This sequence continues until all target levels are satisfied, whereupon a summary is written.

SUBROUTINE - *WRPT1*

This routine writes a final summary of the simulation results. The summary includes pertinent information at the beginning and end of each reach as well as maximum, minimum, and average conditions within the reach.

SUBROUTINE - *WRPT2*

This routine writes an intermediate summary of the simulation results. The summary can be obtained at pre-selected time intervals. For every reach, WRPT2 writes the concentration of the quality constituent of interest for each computational element in the system.

III. QUAL-I INPUT DATA DESCRIPTION

All of the input data required by QUAL-I are in card form. The card data are itemized on the input forms shown in Figures III-1A through III-1E, and described in detail by card-type in Figure III-2. Figure III-3 displays the sequence in which the cards must enter the computer. This input format is quite flexible; the types of cards permitted are as follows:

Title Data Cards

TITLE1
TITLE2
TITLE3
TITLE4
TITLE5
TITLE6
TITLE7
TITLE8
ENDTITLE

Type 1 Data Cards

LIST DATA INPUT
WRITE FINAL SUMMARY
FLØW AUGMENTATIØN
MØDEL ØPTIØN
NUMBER ØF REACHES
NUM ØF HEADWATERS
TIME STEP (HØURS)
MAXIMUM RØUTE TIME (HRS)
LATITUDE ØF BASIN (DEG)
STANDARD MERIDIAN (DEG)
EVAP. CØEF.,(AE)
ELEV. ØF BASIN (FEET)
NØ. ØF CØNS. TØ RØUTE
ENDATA1

NUMBER ØF JUNCTIØNS
NUMBER ØF WASTE LØADS
LNTH. CØMP. ELEMENT (MI)
TIME INCR. FØR RPT2 (HRS)
LØNGITUDE ØF BASIN (DEG)
DAY ØF YEAR START TIME
EVAP. CØEF., (BE)
DUST ATTENUATIØN CØEF.

Type 2 Data Cards

STREAM REACH
ENDATA2

Type 3 Data Cards

FLØW AUGMT. SOURCES
ENDATA3

Type 4 Data Cards

FLAG FIELD
ENDATA4

Type 5 Data Cards

HYDRAULICS
ENDATA5

Type 6 Data Cards

REACT CØEF
ENDATA6

Type 7 Data Cards

INITIAL CØNDITIØNS
ENDATA7

Type 8 Data Cards

RUNØFF CØNDITIØNS
ENDATA8

Type 9 Data Cards

STREAM JUNCTIØN
ENDATA9

Type 10 Data Cards

HEADWATER
ENDATA10

Type 11 Data Cards

WASTE LØAD
ENDATA11

Type 12 Data Cards

LØCAL CLIMATØLØGY

TEXAS WATER DEVELOPMENT BOARD
STREAM QUALITY ROUTING MODEL
QUAL-I

Keypunch 026 029

User _____ Form (A) of (E)

Page ____ of ____

TITLE DATA

TITLE DATA

CARD TYPE	ALPHANUMERIC NAME
TITLE1	TWDB STREAM QUALITY RØUTING FLØW AUGMENTATIØN MØDEL
TITLE2	NAME ØF BASIN =
TITLE3	CØNSERVATIVE MINERAL I (MG/L x 10) =
TITLE4	CØNSERVATIVE MINERAL II (MG/L x 10) =
TITLE5	CØNSERVATIVE MINERAL III (MG/L x 10) =
TITLE6	TEMPERATURE IN DEGREES FAHRENHEIT
TITLE7	BIØCHEMICAL ØXYGEN DEMAND IN MG/L
TITLE8	DISSØLVED ØXYGEN CØNC. IN MG/L
ENDTITLE	

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

PROGRAM ANALYSIS CONTROL DATA

TYPE 1 DATA

CARD TYPE			
LIST DATA INPUT			
WRITE FINAL SUMMARY			
FLØW AUGMENTATIØN			
MØDEL ØPTIØN =			
NUMBER ØF REACHES =		NUMBER ØF JUNCTIØNS =	
NUM ØF HEADWATERS =		NUMBER ØF WASTE LØADS =	
TIME STEP (HØURS) =		LNTH. CØMP. ELEMENT (MI) =	
MAXIMUM RØUTE TIME (HRS) =		TIME INC. FØR RPT2 (HRS) =	
LATITUDE ØF BASIN (DEG) =		LØNGITUDE ØF BASIN (DEG) =	
STANDARD MERIDIAN (DEG) =		DAY ØF YEAR START TIME =	
EVAP. CØEF.(AE) =		EVAP. CØEF.(BE) =	
ELEV. ØF BASIN (FEET) =		DUST ATTENUATIØN CØEF. =	
NØ. ØF CØNS. TØ RØUTE =			
ENDATA1			

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Note: Decimals on these forms have been placed in approximate positions. They may be repositioned in the field according to the user's needs.

FIGURE III-1A

TEXAS WATER DEVELOPMENT BOARD
STREAM QUALITY ROUTING MODEL
QUAL-I

Keypunch 026 029

User _____ Form (B) of (E)

Page ____ of ____

REACH IDENTIFICATION AND RIVER MILE DATA

TYPE 2 DATA

CARD TYPE	REACH IDENTIFICATION: ORDER	REACH IDENTIFICATION: ALPHANUMERIC NAME		RIVER MILE AT HEAD OF REACH		RIVER MILE AT END OF REACH
STREAM REACH	.	RCH =	FRØM	.	TØ	.
STREAM REACH	.	RCH =	FRØM	.	TØ	.
STREAM REACH	.	RCH =	FRØM	.	TØ	.
STREAM REACH	.	RCH =	FRØM	.	TØ	.
STREAM REACH	.	RCH =	FRØM	.	TØ	.
ENDATA2						

FLOW AUGMENTATION DATA

TYPE 3 DATA

CARD TYPE		ORDER OF REACH		# OF AUG. SOURCES AVAILABLE	TARGET LEVEL DISSOLVED OXYGEN (MG/L)	ORDER OF AVAILABLE AUGMENTATION SOURCES: 1st	2nd	3rd	4th	5th	6th
FLØW AUGMT SØURCES	RCH =	.		.	.	.	.	.	.	.	.
FLØW AUGMT SØURCES	RCH =	.		.	.	.	.	.	.	.	.
FLØW AUGMT SØURCES	RCH =	.		.	.	.	.	.	.	.	.
FLØW AUGMT SØURCES	RCH =	.		.	.	.	.	.	.	.	.
FLØW AUGMT SØURCES	RCH =	.		.	.	.	.	.	.	.	.
ENDATA3											

COMPUTATIONAL ELEMENT FLAG FIELD DATA

TYPE 4 DATA

CARD TYPE		ORDER OF REACH		NUM. OF COMP. ELEMENTS		COMPUTATIONAL ELEMENT FLAGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FLAG FIELD	RCH =					. . . . .
FLAG FIELD	RCH =					. . . . .
FLAG FIELD	RCH =					. . . . .
FLAG FIELD	RCH =					. . . . .
FLAG FIELD	RCH =					. . . . .
ENDATA4						

FIGURE III-1B

TEXAS WATER DEVELOPMENT BOARD
STREAM QUALITY ROUTING MODEL
QUAL-I

Keypunch 026 029

User _____ Form (C) of (E)

Page ____ of ____

HYDROLOGIC DATA

TYPE 5 DATA

CARD TYPE	ORDER OF REACH		COEFFICIENT OF FLOW FOR VELOCITY	EXPONENT OF FLOW FOR VELOCITY	COEFFICIENT OF FLOW FOR DEPTH	EXPONENT OF FLOW FOR DEPTH	MANNING'S "n"
HYDRAULICS RCH=	.		.	.	.	.	.
HYDRAULICS RCH=	.		.	.	.	.	.
HYDRAULICS RCH=	.		.	.	.	.	.
HYDRAULICS RCH=	.		.	.	.	.	.
HYDRAULICS RCH=	.		.	.	.	.	.
ENDATA5							

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

REACTION RATE CONSTANTS DATA

TYPE 6 DATA

CARD TYPE	ORDER OF REACH	DEOXYGENATION COEFFICIENT (1/DAY)	BOD REMOVAL DUE TO SETTLING OUT (1/DAY)	OPTION FOR DETERMINATION OF K2	REAERATION COEFFICIENT (1/DAY)	COEFFICIENT OF FLOW FOR K2	EXPONENT OF FLOW FOR K2
REACT CØEF RCH=	.	.	.	.	.	.	.
REACT CØEF RCH=	.	.	.	.	.	.	.
REACT CØEF RCH=	.	.	.	.	.	.	.
REACT CØEF RCH=	.	.	.	.	.	.	.
REACT CØEF RCH=	.	.	.	.	.	.	.
ENDATA6							

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

INITIAL CONDITIONS DATA

TYPE 7 DATA

CARD TYPE	ORDER OF REACH	TEMPERATURE (°F)	D.O. (MG/L)	BOD (MG/L)	CONSERVATIVE MINERAL I (MG/L)	CONSERVATIVE MINERAL II (MG/L)	CONSERVATIVE MINERAL III (MG/L)
INITIAL CØNDITIØNS RCH=	.	.	.	.	.	.	.
INITIAL CØNDITIØNS RCH=	.	.	.	.	.	.	.
INITIAL CØNDITIØNS RCH=	.	.	.	.	.	.	.
INITIAL CØNDITIØNS RCH=	.	.	.	.	.	.	.
INITIAL CØNDITIØNS RCH=	.	.	.	.	.	.	.
ENDATA7							

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

FIGURE III-1C

TEXAS WATER DEVELOPMENT BOARD
STREAM QUALITY ROUTING MODEL
QUAL-I

Keypunch 026 029

User _____ Form (D) of (E)

Page ____ of ____

INCREMENTAL RUNOFF DATA

TYPE 8 DATA

CARD TYPE	ORDER OF REACH	INCREMENTAL FLOW (CFS)	TEMP. (°F)	D.O. (MG/L)	BOD (MG/L)	CONSERVATIVE MINERAL I (MG/L)	CONSERVATIVE MINERAL II (MG/L)	CONSERVATIVE MINERAL III (MG/L)
RUNØFF CØNDITIØNS RCH=	.	.	.	.	.	.	.	.
RUNØFF CØNDITIØNS RCH=	.	.	.	.	.	.	.	.
RUNØFF CØNDITIØNS RCH=	.	.	.	.	.	.	.	.
RUNØFF CØNDITIØNS RCH=	.	.	.	.	.	.	.	.
RUNØFF CØNDITIØNS RCH=	.	.	.	.	.	.	.	.
ENDATA8								

STREAM JUNCTION DATA

TYPE 9 DATA

CARD TYPE	ORDER OF JUNCTION	JUNCTION IDENTIFICATION	ELEMENT # UPSTREAM OF JUNC.	ELEMENT # DOWNSTRM. OF JUNC.	ELEMENT # ON TRIBUTARY
STREAM JUNCTIØN	.	JNC=	.	.	.
STREAM JUNCTIØN	.	JNC=	.	.	.
STREAM JUNCTIØN	.	JNC=	.	.	.
STREAM JUNCTIØN	.	JNC=	.	.	.
STREAM JUNCTIØN	.	JNC=	.	.	.
ENDATA9					

HEADWATER SOURCES DATA

TYPE 10 DATA

CARD TYPE	HEADWATER IDENTIFICATION: ORDER	HEADWATER IDENTIFICATION: ALPHANUMERIC NAME	HEADWATER FLOW (CFS)	TEMP. (°F)	D.O. (MG/L)	BOD (MG/L)	CONS. MINERAL I (MG/L)	CONS. MINERAL II (MG/L)	CONS. MINERAL III(MG/L)
HEADWATER	.	HDW=	.	.	.	.	.	.	.
HEADWATER	.	HDW=	.	.	.	.	.	.	.
HEADWATER	.	HDW=	.	.	.	.	.	.	.
HEADWATER	.	HDW=	.	.	.	.	.	.	.
HEADWATER	.	HDW=	.	.	.	.	.	.	.
ENDATA10									

FIGURE III-1D

TEXAS WATER DEVELOPMENT BOARD
STREAM QUALITY ROUTING MODEL
QUAL-I

Keypunch 026 029

User _____ Form (E) of (E)

Page ____ of ____

WASTE LOADINGS AND WITHDRAWALS DATA

TYPE 11 DATA

CARD TYPE	WASTE LOAD OR WITHDRAWAL IDENTIFICATION: ORDER	WASTE LOAD OR WITHDRAWAL IDENTIFICATION: ALPHANUMERIC NAME	PERCENT TREATMENT	WASTE FLOW OR WITHDRAWAL (CFS)	TEMP. (°F)	D.O. (MG/L)	BOD (MG/L)	CONS. MINERAL I (MG/L)	CONS. MINERAL II (MG/L)	CONS. MINERAL III(MG/L)
WASTE LØAD	.	WSL=	.	.	.	.	.	.	.	.
WASTE LØAD	.	WSL=	.	.	.	.	.	.	.	.
WASTE LØAD	.	WSL=	.	.	.	.	.	.	.	.
WASTE LØAD	.	WSL=	.	.	.	.	.	.	.	.
WASTE LØAD	.	WSL=	.	.	.	.	.	.	.	.
ENDATA11										

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

LOCAL CLIMATØLOGICAL DATA*

TYPE 12 DATA

CARD TYPE	MONTH, DAY, AND YEAR	HOUR OF DAY	CLOUDINESS (TENTHS)	DRYBULB TEMPERATURE (°F)	WETBULB TEMPERATURE (°F)	BAROMETRIC PRESSURE (IN HG)	WIND SPEED (KNOTS)
LØCAL CLIMATØLØGY	- -	300	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	600	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	900	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	1200	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	1500	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	1800	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	2100	.	.	.	.	.
LØCAL CLIMATØLØGY	- -	2400	.	.	.	.	.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

* *Data must be chronologically ordered.*

FIGURE III-1E

FIGURE III-2 QUAL-I INPUT FILE DESCRIPTION

CARD OR FIELD ID	DESCRIPTION	PROGRAM VARIABLE
TITLE1 TITLE2 TITLE3 TITLE4 TITLE5 TITLE6 TITLE7 TITLE8	Columns (1-80) This data consists of eight (8) cards as listed to the left. The data is printed in the order that each card is supplied to the computer. Any alphanumeric or other permissible character can be supplied to this title data array.	TITLE
ENDTITLE	This card must be the last TITLE data card. The computer recognizes this as the last TITLE card and expects TYPE 1 data to follow.	ENDT
Problem Analysis Control Data	Listed below are detailed descriptions of the variables contained on this set of cards. Due to space limitations, only the first portion of each card is listed at the left.	
LIST DATA INPUT	If any characters other than those shown are inserted in the first four columns of this card, the input data will not be listed.	ILIST
UNIT FINAL SUM	If any characters other than those shown are inserted in the first four columns of this card, the final summary will not be written.	IRPTI
FLOW AUGMT	If any characters other than those shown are inserted in the first four columns of this card, flow augmentation requirements will not be checked and computed.	IAUGOP
MODEL OPTION	This variable determines which quality constituent(s) are to be routed. Columns (26-35) MODOPT = 1 (Temp + BOD/DO + Con. Mineral) MODOPT = 2 (Temp + BOD/DO) MODOPT = 3 (BOD/DO) MODOPT = 4 (Conservative Minerals + Temp) MODOPT = 5 (Temp) MODOPT = 6 (BOD/DO + Con. Minerals) MODOPT = 7 (Conservative Minerals)	MODOPT
NUMB OF REACHES	The number of reaches into which the stream system is broken down (maximum of 25). Columns (26-35)	NREACH
NUMBER OF JUNC	The number of stream junctions (confluences) within the stream system (maximum of 5). Columns (71-80)	NJUNC
NUM OF HDWATERS	The number of headwater sources within the stream system (maximum of 5). Columns (26-35)	NHWTRS
NUMBER OF WASTE LOADS	The number of waste inputs or withdrawals within the stream system. (maximum of 25). Columns (71-80)	NWASTE
TIME STEP	The time interval (in hours) over which the solutions to the routing equations are advanced. Columns (26-35)	DELT
LNTH COMP ELEMENT	The space interval (in miles) over which the routing equations are integrated. Columns (71-80)	DELX

CARD OR FIELD ID	DESCRIPTION	PROGRAM VARIABLE
MAXI ROUTE TIME	The approximate time (in hours) required for a particle of water at the uppermost point in the system to reach the end of the system. This is the time required for steady-state conditions to be reached. Columns (26-35)	TMAX
TIME INCR RPTI	The time increment for generation of intermediate summary reports. The minimum is PTIME = DELT, and the maximum is PTIME = TMAX. PTIME should be some multiple of DELT. Columns (71-80)	PTIME
LATI OF BASIN	The mean latitude (degrees) of the stream basin. If temperature is not being routed, characters other than those shown may be inserted in the first four columns of this card. Columns (26-35)	LAT
LONG OF BASIN	The mean longitude (degrees) of the stream basin. If temperature is not being routed, characters other than those shown may be inserted in the first four columns of this card. Columns (71-80)	LLM
STAN MERIDIAN	The standard meridian (degrees) for the area in which the stream system is located. This is some multiple of 15 degrees east or west of Greenwich, England. For the Central Time Zone in the United States this is 90 degrees west. Different characters may be inserted in the first four columns if temperature is not being routed. Columns (26-35)	LSM
DAY OF YEAR	The day of the year on which the routing is begun. Different characters may be inserted in the first four columns if temperature is not being routed. Columns (71-80)	DAYOFY
EVAP COEF.(AE)	Evaporation coefficient (in Ft/Hour/in. Hg). If temperature is not being routed, different characters may be inserted in the first four columns. Columns (26-35)	AE
EVAP COEF.(BE)	Evaporation coefficient (in Ft/Hour/in. Hg/MPH). If temperature is not being routed, different characters may be inserted in the first four columns of this card. Columns (71-80)	BE
ELEV OF BASIN	Mean elevation (in feet) of the area in which the stream system is located. Columns (26-35)	ELEV
DUST ATTENU	Dust attenuation coefficient for solar radiation. May be left blank if temperature is not being routed. Columns (71-80)	DAT
NO. OF CONS	Number of conservative minerals to be routed. Maximum is three (3). Columns (26-35)	NCS
ENDATA1	This card must be the last TYPE 1 data card. The computer recognizes this card as the last TYPE 1 data card and expects TYPE 2 data to follow.	ENDA

CARD OR FIELD ID	DESCRIPTION	PROGRAM VARIABLE
Reach Ident. and River Mile	Listed below are detailed descriptions of the data associated with the configuration of the stream system. There must be a total of (NREACH+1) TYPE 2 data cards.	
STREAM REACH	See Following Descriptions	
REACH ORDER	This is the order number of the reach. The reaches are ordered starting from the uppermost point in the system. When a junction is reached the order is continued from the uppermost point on the tributary. Columns (16-20)	NRCH
	Insert an alphanumeric name for the name of the reach. Columns (26-40)	RCHID
FROM RIVER MILE	River mile at the head of the reach. Columns (51-60)	RMTHOR
TO RIVER MILE	River mile at the end of the reach. Columns (71-80)	
ENDATA2	This card must be the last TYPE 2 data card. The computer recognizes this card as the last TYPE 2 data card and expects TYPE 3 data to follow.	
Flow Augmentation Data	Listed below are detailed descriptions of the data associated with determining flow augmentation requirements and available sources of flow augmentation. There must be (NREACH+1) TYPE 3 data cards.	
FLOW AUGMT	See Following Descriptions.	
REACH ORDER	This is the order of the reach. Columns (26-30)	NRCH
AUG. SOURCES	The number of headwater sources which are available for flow augmentation to this reach. Columns (36-40)	KHWAR
TARGET LEVEL	The minimum allowable dissolved oxygen concentration (in MG/L) within this reach. Columns (41-50)	TARGDO
ORDER OF SOURCES	The order of the headwater sources which are available for flow augmentation to this reach. The headwater sources are ordered from the uppermost point in the stream system. Columns (51-80)	IAUGDO
ENDATA3	This card must be the last TYPE 3 data card. The computer recognizes this card as the last TYPE 3 data card and expects TYPE 4 data to follow.	ENDA

FIGURE III-2 QUAL-I INPUT FILE DESCRIPTION

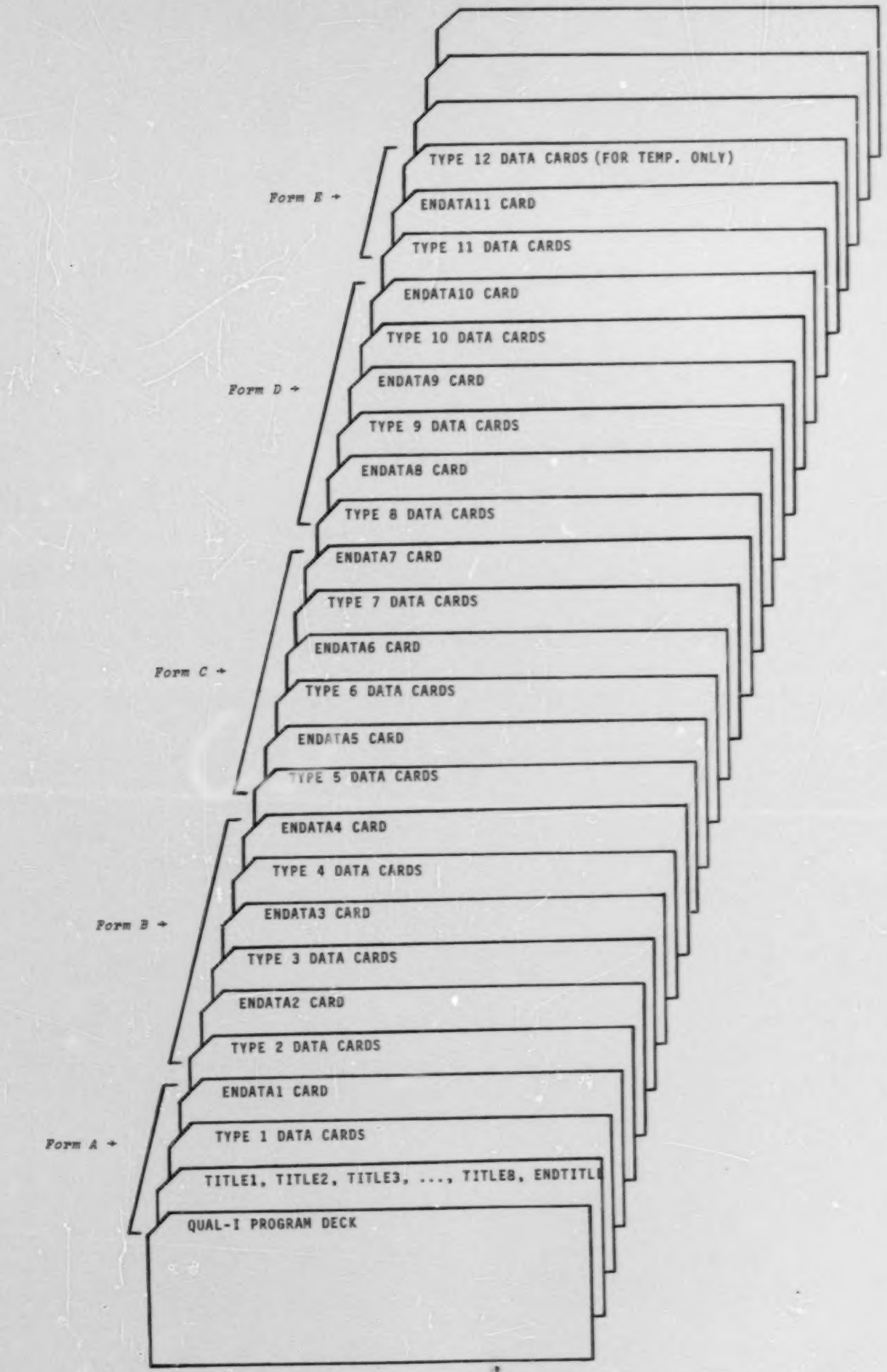
CARD OR FIELD ID	DESCRIPTION	PROGRAM VARIABLE
Comp. Element Flag Field	Listed below are detailed descriptions of the variables associated with determining the proper form of routing equations. There must be (NREACH+1) TYPE 4 data cards.	
FLAG FIELD	See following Descriptions	
REACH ORDER	This is the order number of the reach. Columns (16-20)	NRCH
NUM OF ELEMENTS	This is the number of computational (control) elements into which this reach has been divided. Columns (26-30)	NCELRH
FLAGS	These are numbers in a set (NCELRH) that determine the proper form of the routing equation to be used. The set has a maximum of twenty elements. Columns (41-80) IFLAG=1 Element representing a headwater source. IFLAG=2 Element with no external input or withdrawals other than incremental. IFLAG=3 Element on the mainstream immediately upstream from a stream junction. IFLAG=4 Element which represents a stream junction. IFLAG=5 Last element within the stream system. IFLAG=6 Element with a waste input. IFLAG=7 Element with a withdrawal.	IFLAG
ENDATA4	This card must be the last TYPE 4 data card. The computer recognizes this card as the last TYPE 4 data card and expects TYPE 5 data to follow.	
Hydrologic Data	Listed below are detailed descriptions of the variables associated with determining the hydraulic conditions in the system. There must be a total of (NREACH+1) TYPE 5 data cards.	
HYDRAULICS	See Description Below	
REACH ORDER	This is the order number of the reach. Columns (16-20)	NRCH
COEF OF Q FOR V	This is the coefficient of flow ($V=aQ^b$) for determining the velocity within this reach. Columns (31-40)	COEFQV
EXP OF Q FOR V	This is the exponent of flow ($V=aQ^b$) for determining the velocity within this reach. Columns (41-50)	EXPOQV
COEF OF Q FOR D	This is the coefficient of flow ($D=cQ^d$) for determining the depth within this reach. Columns (51-60)	COEFQH
EXP OF Q FOR D	This is the exponent of flow ($D=cQ^d$) for determining the depth within this reach. Columns (61-70)	EXPOQH
CHANNEL ROUGH	This is the Manning's "n" channel roughness coefficient. Columns (71-80)	CMANN
ENDATA5	This card must be the last TYPE 5 data card. The computer recognizes this card as the last TYPE 5 data card and expects TYPE 6 data to follow.	ENDA
Reaction Rate	Listed below are detailed descriptions of the variables associated with determining reactions for Biochemical Oxygen Demand and Dissolved Oxygen. There must be a total of (NREACH+1) TYPE 6 data cards.	
REACT COEF	See Descriptions Below	
REACH ORDER	This is the order number of the reach. Columns (16-20)	NRCH
DEOXY-GENATION	The deoxygenation coefficient, K_1, (1/DAY) to the base e for this reach. Columns (21-30)	CK1
BOD REMOVAL	The rate of BOD removal, K_3, (1/DAY) to the base e for this reach. This is BOD that is settling out. Columns (31-40)	CK3
OPTION for K_2	Insert a number (1-7) to select an option for determining the reaeration coefficient, K_2, (1/DAY) to the base e for this reach. Columns (41-50) K2OPT=1 Read in values of K_2. K2OPT=2 Calculate K_2 using equation by Churchill (1962). K2OPT=3 Calculate K_2 using equation by O'Conner and Dobbins (1958). K2OPT=4 Calculate K_2 using equation by Owens and Gibbs (1964). K2OPT=5 Calculate K_2 using equation by Thackston and Krenkel (1966). K2OPT=6 Calculate K_2 using equation by Langbien and Durum (1967). K2OPT=7 Calculate K_2 using equation of the form $K_2 = aQ^b$	K2OPT
READ IN K_2	Insert a value for K_2 (1/DAY) to the base e if the option for this reach designates reading a value. Columns (51-60)	CK2
COEF OF Q FOR K_2	This is the coefficient of flow ($K_2 = aQ^b$) for determining K_2. Columns (61-70)	COEQK2
EXP OF Q FOR K_2	This is the exponent of flow ($K_2 = aQ^b$) for determining K_2. Columns (71-80)	EXPQK2
ENDATA6	This card must be the last TYPE 6 data card. The computer recognizes this card as the last TYPE 6 data card and expects TYPE 7 data to follow.	ENDA
Initial Stream Conditions	Listed below are detailed descriptions of the variables associated with establishing initial stream conditions. There must be a total of (NREACH+1) TYPE 7 data cards.	
INIT COND	See Descriptions Below	
REACH ORDER	This is the order number of the reach. Columns (26-30)	NRCH
INIT TEMP	The initial temperature of the stream in this reach. Columns (31-40)	TINIT
INIT D.O.	The initial dissolved oxygen concentration (MG/L) of the stream in this reach. Columns (41-45)	DOINIT
INIT BOD	The initial 5-day biochemical oxygen demand (MG/L) of the stream in this reach. Columns (46-50)	BOINIT
CONS M.I	The initial concentration (MG/L) of conservative mineral I in this reach. Columns (51-60)	COINIT
CONS M.II	The initial concentration (MG/L) of conservative mineral II in this reach. Columns (61-70)	COINIT
CONS M.III	The initial concentration (MG/L) of conservative mineral III in this reach. Columns (71-80)	COINIT
ENDATA7	This card must be the last TYPE 7 data card. The computer recognizes this card as the last TYPE 7 data card and expects TYPE 8 data to follow.	ENDA
Incremental Runoff	Listed below are detailed descriptions of the variables associated with incremental runoff. There must be a total of (NREACH+1) TYPE 8 data cards.	
RUNOFF COND	See Descriptions Below	
REACH ORDER	This is the order number of the reach. Columns (26-30)	NRCH
INCR FLOW	The total incremental inflow (cfs) over the entire length of this reach. Columns (31-35)	QI
INCR TEMP	The temperature (degrees F) of the incremental flow into this reach. Columns (36-40)	TI
INCR D.O.	This is the dissolved oxygen concentration (MG/L) of the incremental inflow into this reach. Columns (41-45)	DOI
INCR BOD	This is the biochemical oxygen demand (MG/L) of the incremental inflow into this reach. Columns (46-50)	BODI

FIGURE III-2 QUAL-I INPUT FILE DESCRIPTION

CARD OR FIELD ID	DESCRIPTION	PROGRAM VARIABLE
INCR CM I	This is the concentration (MG/L) of conservative mineral I of the incremental inflow into this reach. Columns (51-60)	CONSI
INCR CM II	This is the concentration (MG/L) of conservative mineral II of the incremental inflow into this reach. Columns (61-70)	CONSI
INCR CM III	This is the concentration (MG/L) of conservative mineral III of the incremental inflow into this reach. Columns (71-80)	CONSI
ENDATA8	This card must be the last TYPE 8 data card. The computer recognizes this card as the last TYPE 8 data card and expects TYPE 9 data to follow.	ENDA
Stream Junction	Listed below are detailed descriptions of the variables associated with indexing the computational elements at a stream junction. There must be (NJUNC+1) TYPE 9 data cards.	
STREAM JUNC	See Descriptions Below	
JUNC ORDER	The is the order number of the stream junction. The junctions are ordered beginning at the uppermost junction in the system. Columns (21-25)	IJUNC
JNC =	Insert an alphanumeric name for the junction. Columns (36-50)	JUNCID
UPSTREAM ELEMENT ORDER	Insert the order number of the last element in the mainstream reach immediately upstream from the junction. The order numbers of the computational elements are generated internally within the program starting from the uppermost point in the system. Columns (56-60)	JUNC
DOWNSTREAM ELEMENT ORDER	Insert the order number of the first element in the mainstream reach immediately downstream from the junction. Columns (66-70)	JUNC
TRIBUTARY ELEMENT ORDER	Insert the order number of the last element in the last reach of the tributary entering the junction. Columns (76-80)	JUNC
ENDATA9	This card must be the last TYPE 9 data card. The computer recognizes this card as the last TYPE 9 data card and expects TYPE 10 data to follow.	ENDA
Headwater Sources	Listed below are detailed descriptions of the variables associated with defining the quantity and quality of the headwater sources. There must be a total of (NHNTRS+1) TYPE 10 data cards.	
HEADWATER	See Descriptions Below	
HDW ORDER	This is the order number of the headwater source. The sources are ordered from the uppermost point in the system. Columns (16-20)	NHW
HDW =	Insert an alphanumeric name for the headwater source. Columns (26-40)	HWTRID
HDWATER FLOW	This is the discharge (cfs) at this headwater source. Columns (41-50)	HWFLOW
HDWATER TEMP	This is the temperature (degrees f) of the discharge at this headwater source. Columns (51-55)	HWTEMP
HDWATER D.O.	This is the dissolved oxygen concentration (MG/L) of the discharge at this headwater source. Columns (56-60)	HWDO
HDWATER BOD	This is the 5-day biochemical oxygen demand (MG/L) of the discharge at this headwater source. Columns (61-65)	HWBOD
HDW CM I	This is the concentration (MG/L) of conservative mineral I in the discharge at this headwater source. Columns (66-70)	HWCONS
HDW CM II	This is the concentration (MG/L) of conservative mineral II in the discharge at this headwater source. Columns (71-75)	HWCONS
HDW CM III	This is the concentration (MG/L) of conservative mineral III in the discharge at this headwater source. Columns (76-80)	HWCONS
ENDATA10	This must be the last TYPE 10 data card. The computer recognizes this as the last TYPE 10 data card and expects TYPE 11 data to follow.	ENDA
Waste Loadings and Withdrawals	Listed below are detailed descriptions of the variables associated with defining the quantity and quality of waste loads. There must be a total of (NWASTE+1) TYPE 11 data cards.	
WASTE LOAD	See Descriptions Below	
WASTE LOAD ORDER	The order number of the waste loads. They are ordered from the uppermost point in the system. Columns (11-15)	NWS
WSL =	Insert an alphanumeric name for the waste load. Columns (21-35)	WASTID
TREATMT EFF.	The percent treatment efficiency of the waste load contributor. The value is zero for a withdrawal, point source (unmodeled tributary), or if the effluent BOD of an STP (instead of influent to an STP) is used. Columns (36-40)	TRFACT
WASTE FLOW	The discharge (cfs) at a point source. This is positive for an STP effluent and negative for a withdrawal. Columns (41-50)	WSFLOW
WASTE TEMP	The temperature (degrees F) of the waste discharge or point source. The temperature is zero for a withdrawal. Columns (51-55)	WSTEMP
WASTE D.O.	The dissolved oxygen concentration (MG/L) of the waste discharge or point source. It is zero for a withdrawal. Columns (56-60)	WSDO
WASTE BOD	The 5-day biochemical oxygen demand (MG/L) of the waste discharge or point source. It is zero for a withdrawal. Columns (61-65)	WSBOD
WASTE CM I	The concentration in (MG/L) of conservative mineral I in the discharge of this waste load. It is zero for a withdrawal. Columns (66-70)	WSCONS
WASTE CM II	The concentration in (MG/L) of conservative mineral II in the discharge of this waste load.. It is zero for a withdrawal. Columns (71-75)	WSCONS
WASTE CM III	The concentration in (MG/L) of conservative mineral III in the discharge of this waste load. It is zero for a withdrawal. Columns (76-80)	WSCONS
ENDATA11	This must be the last TYPE 11 data card. The computer recognizes this as the last TYPE 11 data card and expects no more data at this point, unless temperature is being routed.	ENDA
Local Clim. Data	Listed below are detailed descriptions of the variables associated with computing heat exchange across the water surface of the stream system. This data is read in sequentially during execution at time intervals of three (3) hours. It is required only when temperature is being routed.	
LOCAL CLIM.	See Descriptions Below	
MONTH, DAY, AND YEAR	Two-digital representation of month, day, and year for each set of climatological data. Columns (18-25)	CLOUD
HOUR OF DAY	Hour of calendar day counting from midnight. Columns (26-30)	DRYBLB
CLOUDINESS	The fraction (in tenths) of cloud cover. Columns (31-40)	WETBLB
DRYBULB TEMP	The drybulb temperature (degrees F) of the air. Columns (41-50)	ATMPR
WETBULB TEMP	The wetbulb temperature (degrees F) of the air. Columns (51-60)	WIND
BAROMETRIC	The barometric pressure (in Hg). Columns (61-70)	
WIND SPEED	The velocity of the wind (knots). Columns (71-80)	

FIGURE III-3

INPUT DATA ORGANIZATION



IV. QUAL-I PROGRAM OUTPUT FILE DESCRIPTION

The output generated by QUAL-I is of two forms: (1) an intermediate report and (2) a final summary. The intermediate report is given by SUBROUTINE *WRPT2*, and the final summary is given by SUBROUTINE *WRPT1*. Example listings of the printer outputs for (1) Flow Augmentation, (2) Temperature Routing, and (3) Conservative Mineral Routing are shown in the following pages.

BOD/DO SIMULATION

WITH

FLOW AUGMENTATION

TEXAS WATER DEVFLOPMENT BOARD
* * * DATA LIST FOR STREAM QUALITY ROUTING MODEL * * *

$$$ (PRORLFM TITLFS) $$$

CARD TYPE	QUAL-I PROGRAM TITLES
TITLE1	TWDB STREAM QUALITY ROUTING-FLOW AUGMENTATION MODEL
TITLE2	NAME OF BASIN = SAN ANTONIO RIVER
TITLE3	CONSERVATIVE MINERAL I (MG/L X 10) = SULFATE AFTER
TITLE4	CONSERVATIVE MINERAL II (MG/L X 10) = CHLORIDE AFTER
TITLE5	CONSFRVATIVF MINERAL III (MG/L X 10) = T. D. S. AFTER
TITLE6	TEMPERATURE IN DEGREES FAHRENHEIT AFTER
TITLE7	BIOCHEMICAL OXYGEN DEMAND IN MG/L AFTER
TITLE8	DISSOLVED OXYGEN CONC. IN MG/L AFTER
ENDTITL	

$$$ DATA TYPE 1 (CONTROL DATA) $$$

CARD TYPE		
LIST DATA INPUT		-0.00000
WRITE FINAL SUMMARY		-0.00000
FLOW AUGMENTATION		-0.00000
MODEL OPTION	=	3.00000
NUMBER OF REACHES	=	8.00000
NUM OF HEADWATERS	=	2.00000
TIME STEP (HOURS)	=	3.00000
MAXIMUM ROUTE TIME (HRS)	=	240.00000
LATITUDE OF BASIN (DEG)	=	29.50000
STANDARD MERIDIAN (DEG)	=	90.00000
EVAP. COFF.. (AE)	=	.00068
ELEV. OF BASIN (FEET)	=	725.00000
NO. OF CONS. TO ROUTE	=	3.00000
ENDATA1		-0.00000

CARD TYPE		
		-0.00000
		-0.00000
		-0.00000
		-0.00000
NUMBER OF JUNCTIONS	=	1.00000
NUMBER OF WASTE LOADS	=	4.00000
LNTH. COMP. ELEMENT(MI)	=	1.00000
TIME INCR FOR RPT2 (HRS)	=	240.00000
LONGITUDE OF BASIN (DEG)	=	98.50000
DAY OF YEAR START TIME	=	168.00000
EVAP. COEF.. (BE)	=	.00027
DUST ATTENUATION COEF.	=	.04000
		-0.00000
		-0.00000

$$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$

CARD TYPE	REACH	ORDER AND IDENT		R. MILE		R. MILE
STREAM REACH	1	RCH = S A R SOURCE	FROM	232.0	TO	222.0
STREAM REACH	2	RCH = RILLING ROAD	FROM	222.0	TO	210.0
STREAM REACH	3	RCH = M R + LEON C	FROM	10.0	TO	0.0
STREAM REACH	4	RCH = ELMENDORF	FROM	210.0	TO	190.0
STREAM REACH	5	RCH = FLORESVILLE	FROM	190.0	TO	170.0
STREAM REACH	6	RCH = FLORE TO F C	FROM	170.0	TO	150.0
STREAM REACH	7	RCH = FALLS C-CIBO	FROM	150.0	TO	130.0
STREAM REACH	8	RCH = CIBOLO-RUNGE	FROM	130.0	TO	110.0
ENDATA2	-0			-0.0		-0.0

$$$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) $$$

CARD TYPE	REACH	AVAIL HDWS	TARGET	ORDER OF AVAIL SOURCES					
FLOW AUGMT. SOURCES	1	0	4.0	1	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	2	0	4.0	1	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	3	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	4	2	4.0	1	2	-0	-0	-0	-0
FLOW AUGMT. SOURCES	5	2	4.0	1	2	-0	-0	-0	-0
FLOW AUGMT. SOURCES	6	2	4.0	1	2	-0	-0	-0	-0
FLOW AUGMT SOURCE	7	2	4.0	1	2	-0	-0	-0	-0
FLOW AUGMT. SOURCES	8	2	4.0	1	2	-0	-0	-0	-0
ENDATA3	-0	-0	-0.0	-0	-0	-0	-0	-0	-0

$$$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) $$$

CARD TYPE	REACH	ELEMENTS/REACH	COMPUTATIONAL FLAGS
FLAG FIELD	1	10	1 2 2 2 2 2 2 2 2 2-0-0-0-0-0-0-0-0-0-0
FLAG FIELD	2	12	2 2 6 2 2 2 2 2 2 2 2 2 3-0-0-0-0-0-0-0-0-0
FLAG FIELD	3	10	1 2 2 6 2 2 2 2 2 2-0-0-0-0-0-0-0-0-0-0
FLAG FIELD	4	20	4 2 2 2 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	5	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	6	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	7	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 6 2
FLAG FIELD	8	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5
ENDATA4	-0	-0	-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0

$$$ DATA TYPE 5 (HYDRAULIC COEFFICIENTS FOR DETERMINING VELOCITY AND DEPTH) $$$

CARD TYPE	REACH	COEFQV	EXPOQV	COEFQH	EXPOQH	CMANN
HYDRAULICS	1	.333	.335	.511	.264	.035
HYDRAULICS	2	.333	.335	.511	.264	.035
HYDRAULICS	3	.256	.381	.299	.381	.035
HYDRAULICS	4	.105	.414	.440	.414	.035
HYDRAULICS	5	.105	.414	.440	.414	.035
HYDRAULICS	6	.105	.414	.440	.414	.035
HYDRAULICS	7	.142	.414	.440	.414	.035
HYDRAULICS	8	.142	.414	.440	.414	.035
ENDATA5	-0	-0.000	-0.000	-0.000	-0.000	-0.000

$$$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND REAERATION) $$$

CARD TYPE	REACH	K1	K3	K2OPT	K2	COEQK2	EXPQK2
REACT COEF	1	.32	0.00	2	7.70	0.000	0.000
REACT COEF	2	.32	0.00	2	10.20	0.000	0.000
REACT COEF	3	.32	0.00	2	7.30	0.000	0.000
REACT COEF	4	.32	0.00	2	1.50	0.000	0.000
REACT COEF	5	.25	0.00	2	1.00	0.000	0.000
REACT COEF	6	.25	0.00	2	1.00	0.000	0.000
REACT COEF	7	.20	0.00	2	1.00	0.000	0.000
REACT COEF	8	.05	0.00	2	1.00	0.000	0.000
ENDATA6	-0	-0.00	-0.00	-0	-0.00	-0.000	-0.000

$$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$

CARD TYPE	REACH	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
INITIAL CONDITIONS	1	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	2	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	3	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	4	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	5	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	6	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	7	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	8	81.4	6.0	1.0	0.0	0.0	0.0
ENDATA7	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 8 (RUNOFF CONDITIONS) $$$

CARD TYPE	REACH	Q	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
RUNOFF CONDITIONS	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	5	15.0	81.4	8.0	2.0	185.3	119.0	840.0
RUNOFF CONDITIONS	6	15.0	81.4	8.0	2.0	453.3	383.3	1664.6
RUNOFF CONDITIONS	7	24.0	81.4	8.0	2.0	200.0	200.0	1000.0
RUNOFF CONDITIONS	8	24.0	81.4	8.0	2.0	170.0	170.0	800.0
ENDATA8	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$

CARD TYPE	JUNCTION ORDER AND IDENT		UPSTRM	DOWNSTRM	TRIB
STREAM JUNCTION	1	JNC = S.A.R. + M.R.	22	33	32
ENDATA9	-0		-0	-0	-0

$$$ DATA TYPE 10 (HEADWATER SOURCES) $$$

CARD TYPE	HDWATER ORDER AND IDENT		FLOW	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
HEADWATER	1	HDW = S.A.R. SOURCE	14.0	81.4	7.5	2.0	36.0	42.0	299.0
HEADWATER	2	HDW = MEDINA RIVER	60.6	78.8	7.5	1.0	34.4	11.7	234.8
ENDATA10	-0		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 11 (WASTE LOADINGS) $$$

CARD TYPE	WASTE LOAD ORDER AND IDENT		EFF	FLOW	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
WASTE LOAD	1	WSL = RILLING STP	0.00	97.0	82.4	7.0	38.0	132.0	139.8	764.9
WASTE LOAD	2	WSL = LEON CRK STP	0.00	17.4	78.8	7.5	35.0	113.0	134.0	760.0
WASTE LOAD	3	WSL = BRAU+CALAVER	1.00	-64.0	0.0	0.0	0.0	0.0	0.0	0.0
WASTE LOAD	4	WSL = CIBO CRK TRB	0.00	28.0	81.4	8.0	1.6	242.0	169.0	833.0
ENDATA11	-0		-0.00	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

EXAMPLE OF INTERMEDIATE SUMMARY FOR ONE TRIAL AUGMENTATION

* * * REACHES WITH OXYGEN DEFICIT * * *

REACH NO.	REACH IDENTIFICATION	MINIMUM DO.	RIVER MILE
4	RCH = ELMENDORF	3.5	193.0
5	RCH = FLORESVILLE	3.7	189.0

* * * FLOW AUGMENTATION REQUIRED * * *

HEADWATER NO.	HEADWATER IDENTIFICATION	EXISTING HEADWATER FLOW (CFS)	AUG. REQUIRED (CFS)
1	HDW = S.A.R. SOURCE	31.1	11.9
2	HDW = MEDINA RIVER	77.7	11.9

BIOCHEMICAL OXYGEN DEMAND IN MG/L AFTER 10.00 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	2.0	1.9	1.9	1.8	1.8	1.7	1.7	1.7	1.6	1.6										
2	1.5	1.5	26.5	26.1	25.7	25.3	24.9	24.5	24.1	23.7	23.4	23.0								
3	1.0	1.0	.9	6.4	6.3	6.1	6.0	5.9	5.8	5.7										
4	15.2	14.8	14.4	14.0	13.7	13.3	12.9	12.5	12.1	11.8	11.4	11.1	10.8	10.5	10.1	9.8	9.6	9.3	9.0	8.7
5	8.5	8.3	8.1	7.9	7.7	7.5	7.3	7.1	6.9	6.7	6.6	6.4	6.2	6.1	5.9	5.8	5.6	5.5	5.4	5.2
6	5.1	5.0	4.8	4.7	4.6	4.5	4.4	4.3	4.2	4.1	4.0	3.9	3.8	3.7	3.6	3.5	3.5	3.4	3.3	3.2
7	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.6	2.5	2.5	2.5	2.3	2.3
8	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2

DISSOLVED OXYGEN CONC. IN MG/L AFTER 10.00 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	7.6	7.6	7.6	7.6	7.7	7.7	7.7	7.7	7.7	7.7										
2	7.7	7.7	7.0	6.8	6.6	6.5	6.4	6.3	6.3	6.2	6.2	6.2								
3	7.6	7.6	7.6	7.6	7.5	7.5	7.4	7.4	7.4	7.4										
4	6.6	6.2	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.3	4.1	4.0	4.0	3.9	3.8	3.8	3.8	3.8	3.8	3.8
5	3.9	3.9	4.0	4.1	4.1	4.2	4.3	4.4	4.4	4.5	4.6	4.6	4.7	4.8	4.8	4.9	5.0	5.0	5.1	5.1
6	5.2	5.2	5.3	5.4	5.4	5.5	5.5	5.6	5.6	5.7	5.7	5.8	5.8	5.8	5.9	5.9	6.0	6.0	6.0	6.1
7	6.1	6.2	6.3	6.3	6.4	6.4	6.5	6.5	6.6	6.6	6.6	6.7	6.7	6.7	6.8	6.8	6.8	6.9	7.0	7.0
8	7.0	7.0	7.1	7.1	7.1	7.1	7.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.3	7.3	7.3	7.3

EXAMPLE OF FINAL SUMMARY FOR ONE REACH

* * * FINAL REPORT * * *

REACH NO. 5 (RCH = FLORESVILLE)

PARAMETER		HEAD OF REACH	END OF REACH	MAXIMUM	MINIMUM	AVERAGE
RIVER MILE	=	190.0	170.0			
FLOW (CFS)	=	207.750	222.000	222.000	207.750	214.875
VELOCITY (FPS)	=	.956	.983	.983	.956	.970
DEPTH (FT)	=	4.008	4.119	4.119	4.008	4.064
K1 (1/DAY)	=	.250	.250	.250	.250	.250
K2 (1/DAY)	=	1.088	1.069	1.088	1.069	1.078
K3 (1/DAY)	=	0.000	0.000	0.000	0.000	0.000
TEMP (F)	=	81.400	81.400	81.400	81.400	81.400
BOD (MG/L)	=	8.066	5.083	8.066	5.083	6.454
DO (MG/L)	=	4.055	5.132	5.132	4.055	4.597
CONS ONE (MG/L)	=	0.000	0.000	0.000	0.000	0.000
CONS TWO (MG/L)	=	0.000	0.000	0.000	0.000	0.000
CONS THREE (MG/L)	=	0.000	0.000	0.000	0.000	0.000

TEMPERATURE ROUTING

TEXAS WATER DEVELOPMENT BOARD
* * * DATA LIST FOR STREAM QUALITY ROUTING MODEL * * *

$$$ (PROBLEM TITLES) $$$

CARD TYPE	QUAL-I PROGRAM TITLES
TITLE1	TWDB STREAM QUALITY ROUTING-FLOW AUGMENTATION MODEL
TITLE2	NAME OF BASIN = SAN ANTONIO RIVER
TITLE3	CONSERVATIVE MINERAL I (MG/L X 10) = SULFATE AFTER
TITLE4	CONSERVATIVE MINERAL II (MG/L X 10) = CHLORIDE AFTER
TITLE5	CONSERVATIVE MINERAL III (MG/L X 10) = T. D. S. AFTER
TITLE6	TEMPERATURE IN DEGREES FAHRENHEIT AFTER
TITLE7	BIOCHEMICAL OXYGEN DEMAND IN MG/L AFTER
TITLE8	DISSOLVED OXYGEN CONC. IN MG/L AFTER
ENDTITL	

$$$ DATA TYPE 1 (CONTROL DATA) $$$

CARD TYPE			CARD TYPE		
LIST DATA INPUT		-0.00000			-0.00000
WRITE FINAL SUMMARY		-0.00000			-0.00000
NO FLOW AUGMENTATION		-0.00000			-0.00000
MODEL OPTION	=	5.00000			-0.00000
NUMBER OF REACHES	=	8.00000	NUMBER OF JUNCTIONS	=	1.00000
NUM OF HEADWATERS	=	2.00000	NUMBER OF WASTE LOADS	=	5.00000
TIME STEP (HOURS)	=	1.00000	LNTH. COMP. ELEMENT(MI)	=	1.00000
MAXIMUM ROUTE TIME (HRS)	=	120.00000	TIME INCR FOR RPT2 (HRS)	=	6.00000
LATITUDE OF BASIN (DEG)	=	29.50000	LONGITUDE OF BASIN (DEG)	=	98.50000
STANDARD MERIDIAN (DEG)	=	90.00000	DAY OF YEAR START TIME	=	168.00000
EVAP. COEF.. (AE)	=	.00068	EVAP. COEF.. (BE)	=	.00027
ELEV. OF BASIN (FEET)	=	725.00000	DUST ATTENUATION COEF.	=	.04000
NO. OF CONS. TO ROUTE	=	3.00000			-0.00000
ENDATA1		-0.00000			-0.00000

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$$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$

CARD TYPE	REACH ORDER AND IDENT			R. MILE		R. MILE
STREAM REACH	1	RCH = S A R SOURCE	FROM	232.0	TO	222.0
STREAM REACH	2	RCH = RILLING ROAD	FROM	222.0	TO	210.0
STREAM REACH	3	RCH = M R + LEON C	FROM	10.0	TO	0.0
STREAM REACH	4	RCH = ELMENDORF	FROM	210.0	TO	190.0
STREAM REACH	5	RCH = FLORESVILLE	FROM	190.0	TO	170.0
STREAM REACH	6	RCH = FLORE TO F C	FROM	170.0	TO	150.0
STREAM REACH	7	RCH = FALLS C-CIBO	FROM	150.0	TO	130.0
STREAM REACH	8	RCH = CIBOLO-RUNGE	FROM	130.0	TO	110.0
ENDATA2	-0			-0.0		-0.0

$$$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) $$$

CARD TYPE	REACH	AVAIL HDWS	TARGET	ORDER OF AVAIL SOURCES					
FLOW AUGMT. SOURCES	1	0	4.0	-0	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	2	0	4.0	-0	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	3	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	4	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	5	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	6	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT SOURCE	7	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	8	1	4.0	2	-0	-0	-0	-0	-0
ENDATA3	-0	-0	-0.0	-0	-0	-0	-0	-0	-0

$$$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) $$$

CARD TYPE	REACH	ELEMENTS/REACH	COMPUTATIONAL FLAGS
FLAG FIELD	1	10	1 2 2 2 2 2 2 2 2 2-0-0-0-0-0-0-0-0-0-0
FLAG FIELD	2	12	2 2 6 2 2 2 2 2 2 2 2 3-0-0-0-0-0-0-0-0
FLAG FIELD	3	10	1 2 2 6 2 2 2 2 2 2-0-0-0-0-0-0-0-0-0-0
FLAG FIELD	4	20	4 2 2 2 7 6 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	5	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	6	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	7	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 6 2
FLAG FIELD	8	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5
ENDATA4	-0	-0	-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0

$$$ DATA TYPE 5 (HYDRAULIC COEFFICIENTS FOR DETERMINING VELOCITY AND DEPTH) $$$

CARD TYPE	REACH	COEFQV	EXPOQV	COEFQH	EXPOQH	CMANN
HYDRAULICS	1	.333	.335	.511	.264	.035
HYDRAULICS	2	.333	.335	.511	.264	.035
HYDRAULICS	3	.256	.381	.299	.381	.035
HYDRAULICS	4	.105	.414	.440	.414	.035
HYDRAULICS	5	.105	.414	.440	.414	.035
HYDRAULICS	6	.105	.414	.440	.414	.035
HYDRAULICS	7	.142	.414	.440	.414	.035
HYDRAULICS	8	.142	.414	.440	.414	.035
ENDATA5	-0	-0.000	-0.000	-0.000	-0.000	-0.000

$$$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND REAERATION) $$$

CARD TYPE	REACH	K1	K3	K2OPT	K2	COEQK2	EXPQK2
REACT COEF	1	.32	0.00	2	7.70	0.000	0.000
REACT COEF	2	.32	0.00	2	10.20	0.000	0.000
REACT COEF	3	.32	0.00	2	7.30	0.000	0.000
REACT COEF	4	.32	0.00	2	1.50	0.000	0.000
REACT COEF	5	.25	0.00	2	1.00	0.000	0.000
REACT COEF	6	.25	0.00	2	1.00	0.000	0.000
REACT COEF	7	.20	0.00	2	1.00	0.000	0.000
REACT COEF	8	.05	0.00	2	1.00	0.000	0.000
ENDATA6	-0	-0.00	-0.00	-0	-0.00	-0.000	-0.000

$$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$

CARD TYPE	REACH	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
INITIAL CONDITIONS	1	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	2	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	3	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	4	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	5	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	6	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	7	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	8	81.4	6.0	1.0	0.0	0.0	0.0
ENDATA7	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 8 (RUNOFF CONDITIONS) $$$

CARD TYPE	REACH	Q	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
RUNOFF CONDITIONS	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	5	15.0	81.4	8.0	2.0	185.3	119.0	840.0
RUNOFF CONDITIONS	6	15.0	81.4	8.0	2.0	453.3	383.3	1664.6
RUNOFF CONDITIONS	7	24.0	81.4	8.0	2.0	200.0	200.0	1000.0
RUNOFF CONDITIONS	8	24.0	81.4	8.0	2.0	170.0	170.0	800.0
ENDATA8	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$

CARD TYPE	JUNCTION ORDER AND IDENT		UPSTRM	DOWNSTRM	TRIB
STREAM JUNCTION	1	JNC = S.A.R. + M.R.	22	33	32
ENDATA9	-0		-0	-0	-0

$$$ DATA TYPE 10 (HEADWATER SOURCES) $$$

CARD TYPE	HDWATER ORDER AND IDENT		FLOW	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
HEADWATER	1	HDW = S.A.R. SOURCE	14.0	81.4	7.5	2.0	36.0	42.0	299.0
HEADWATER	2	HDW = MEDINA RIVER	60.6	78.8	7.5	1.0	34.4	11.7	234.8
ENDATA10	-0		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 11 (WASTE LOADINGS) $$$

CARD TYPE	WASTE LOAD ORDER AND IDENT		EFF	FLOW	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
WASTE LOAD	1	WSL = RILLING STP	0.00	97.0	82.4	7.0	38.0	132.0	139.8	764.9
WASTE LOAD	2	WSL = LEON CRK STP	0.00	17.4	78.8	7.5	35.0	113.0	134.0	760.0
WASTE LOAD	3	WSL = BRAU+CALAVER	1.00	-64.0	0.0	0.0	0.0	0.0	0.0	0.0
WASTE LOAD	4	WSL = P P DISCHARGE	0.00	64.0	115.0	0.0	0.0	0.0	0.0	0.0
WASTE LOAD	5	WSL = CIBO CRK TRB	0.00	28.0	81.4	8.0	1.6	242.0	169.0	833.0
ENDATA11	-0		-0.00	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

CARD TYPE	DATE	HOUR	CLOUD	DRYBULB	WETBULB	ATM. PR.	WIND
LOCAL CLIMATOLOGY	6-14-67	300	0.1	77.0	72.0	29.27	6.9
LOCAL CLIMATOLOGY	6-14-67	600	0.6	73.0	71.0	29.27	4.6
LOCAL CLIMATOLOGY	6-14-67	900	1.0	74.0	73.0	29.27	6.9
LOCAL CLIMATOLOGY	6-14-67	1200	0.6	81.0	74.0	29.27	9.2
LOCAL CLIMATOLOGY	6-14-67	1500	0.6	88.0	74.0	29.27	9.2
LOCAL CLIMATOLOGY	6-14-67	1800	0.5	94.0	74.0	29.27	8.1
LOCAL CLIMATOLOGY	6-14-67	2100	0.3	93.0	71.0	29.27	13.8
LOCAL CLIMATOLOGY	6-14-67	2400	0.2	84.0	72.0	29.27	11.5
LOCAL CLIMATOLOGY	6-15-67	300	0.2	78.0	72.0	29.22	11.5
LOCAL CLIMATOLOGY	6-15-67	600	1.0	75.0	72.0	29.22	5.8
LOCAL CLIMATOLOGY	6-15-67	900	0.8	73.0	71.0	29.22	0.0
LOCAL CLIMATOLOGY	6-15-67	1200	0.6	80.0	73.0	29.22	9.2
LOCAL CLIMATOLOGY	6-15-67	1500	0.6	88.0	72.0	29.22	11.5
LOCAL CLIMATOLOGY	6-15-67	1800	0.4	93.0	73.0	29.22	13.8
LOCAL CLIMATOLOGY	6-15-67	2100	0.2	91.0	72.0	29.22	15.0
LOCAL CLIMATOLOGY	6-15-67	2400	0.0	83.0	72.0	29.22	12.6
LOCAL CLIMATOLOGY	6-16-67	300	0.3	77.0	70.0	29.19	10.4
LOCAL CLIMATOLOGY	6-16-67	600	0.3	72.0	69.0	29.19	0.0
LOCAL CLIMATOLOGY	6-16-67	900	1.0	73.0	70.0	29.19	4.6
LOCAL CLIMATOLOGY	6-16-67	1200	0.7	80.0	72.0	29.19	0.0
LOCAL CLIMATOLOGY	6-16-67	1500	0.6	88.0	73.0	29.19	6.9
LOCAL CLIMATOLOGY	6-16-67	1800	0.5	92.0	73.0	29.19	17.3
LOCAL CLIMATOLOGY	6-16-67	2100	0.3	92.0	73.0	29.19	11.5
LOCAL CLIMATOLOGY	6-16-67	2400	0.4	85.0	71.0	29.19	9.2
LOCAL CLIMATOLOGY	6-17-67	300	0.4	79.0	72.0	29.26	5.8
LOCAL CLIMATOLOGY	6-17-67	600	0.4	76.0	71.0	29.26	0.0
LOCAL CLIMATOLOGY	6-17-67	900	0.8	74.0	71.0	29.26	0.0
LOCAL CLIMATOLOGY	6-17-67	1200	0.3	84.0	71.0	29.26	5.8
LOCAL CLIMATOLOGY	6-17-67	1500	0.5	88.0	72.0	29.26	0.0
LOCAL CLIMATOLOGY	6-17-67	1800	0.5	94.0	74.0	29.26	11.5
LOCAL CLIMATOLOGY	6-17-67	2100	0.4	93.0	72.0	29.26	10.4
LOCAL CLIMATOLOGY	6-17-67	2400	0.3	85.0	73.0	29.26	9.2
LOCAL CLIMATOLOGY	6-18-67	300	0.3	81.0	72.0	29.33	4.6
LOCAL CLIMATOLOGY	6-18-67	600	0.4	77.0	72.0	29.33	0.0
LOCAL CLIMATOLOGY	6-18-67	900	0.0	75.0	71.0	29.33	0.0
LOCAL CLIMATOLOGY	6-18-67	1200	0.1	85.0	73.0	29.33	5.8
LOCAL CLIMATOLOGY	6-18-67	1500	0.4	91.0	72.0	29.33	0.0
LOCAL CLIMATOLOGY	6-18-67	1800	0.5	95.0	73.0	29.33	11.5
LOCAL CLIMATOLOGY	6-18-67	2100	0.2	94.0	72.0	29.33	9.2
LOCAL CLIMATOLOGY	6-18-67	2400	0.1	85.0	72.0	29.33	3.4

EXAMPLES OF INTERMEDIATE SUMMARY FOR TWO TIME INCREMENTS

TEMPERATURE IN DEGREES FAHRENHEIT AFTER .25 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	79.2	77.5	76.3	75.5	74.9	74.6	74.4	74.4	74.3	74.3										
2	74.3	74.3	80.8	80.2	79.6	79.1	78.6	78.1	77.8	77.5	77.3	77.1								
3	77.9	77.2	76.7	76.8	76.5	76.3	76.2	76.2	76.2	76.2										
4	76.9	77.4	77.9	78.3	78.3	89.7	88.1	86.1	84.2	82.6	81.3	80.5	79.9	79.5	79.3	79.2	79.1	79.1	79.1	79.0
5	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1
6	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
7	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.3	79.3	79.3	79.3	79.5	79.4
8	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4

TEMPERATURE IN DEGREES FAHRENHEIT AFTER .50 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	84.1	85.4	85.8	85.7	85.4	85.1	84.8	84.6	84.4	84.3										
2	84.2	84.1	83.3	83.9	84.2	84.4	84.4	84.3	84.1	83.9	83.7	83.4								
3	80.7	82.0	82.8	82.5	82.7	82.8	82.8	82.7	82.6	82.5										
4	82.1	81.0	80.4	80.1	80.3	91.5	90.8	90.1	89.2	88.2	87.1	86.0	84.9	84.0	83.2	82.6	82.1	81.8	81.5	81.3
5	81.2	81.2	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0
6	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0
7	81.0	81.0	81.0	81.0	81.0	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1
8	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.0	81.0	81.0	81.0	81.0	81.0

EXAMPLE OF FINAL SUMMARY FOR ONE REACH

* * * FINAL REPORT * * *

REACH NO. 1 (RCH = S A R SOURCE)

PARAMETER		HEAD OF REACH	END OF REACH	MAXIMUM	MINIMUM	AVERAGE
RIVER MILE	=	232.0	222.0			
FLOW (CFS)	=	14.000	14.000	14.000	14.000	14.000
VELOCITY (FPS)	=	.806	.806	.806	.806	.806
DEPTH (FT)	=	1.026	1.026	1.026	1.026	1.026
K1 (1/DAY)	=	.320	.320	.320	.320	.320
K2 (1/DAY)	=	0.000	0.000	0.000	0.000	0.000
K3 (1/DAY)	=	0.000	0.000	0.000	0.000	0.000
TEMP (F)	=	79.712	79.154	79.712	77.513	78.395
BOD (MG/L)	=	1.000	1.000	1.000	1.000	1.000
DO (MG/L)	=	6.000	6.000	6.000	6.000	6.000
CONS ONE (MG/L)	=	0.000	0.000	0.000	0.000	0.000
CONS TWO (MG/L)	=	0.000	0.000	0.000	0.000	0.000
CONS THREE (MG/L)	=	0.000	0.000	0.000	0.000	0.000

CONSERVATIVE MINERAL

ROUTING

TEXAS WATER DEVELOPMENT BOARD
* * * DATA LIST FOR STREAM QUALITY ROUTING MODEL * * *

$$$ (PROBLEM TITLES) $$$

CARD TYPE	QUAL-I PROGRAM TITLES
TITLE1	TWDB STREAM QUALITY ROUTING-FLOW AUGMENTATION MODEL
TITLE2	NAME OF BASIN = SAN ANTONIO RIVER
TITLE3	CONSERVATIVE MINERAL I (MG/L X 10) = SULFATE AFTER
TITLE4	CONSERVATIVE MINERAL II (MG/L X 10) = CHLORIDE AFTER
TITLE5	CONSERVATIVE MINERAL III (MG/L X 10) = T. D. S. AFTER
TITLE6	TEMPERATURE IN DEGREES FAHRENHEIT AFTER
TITLE7	BIOCHEMICAL OXYGEN DEMAND IN MG/L AFTER
TITLE8	DISSOLVED OXYGEN CONC. IN MG/L AFTER
ENDTITL	

$$$ DATA TYPE 1 (CONTROL DATA) $$$

CARD TYPE		CARD TYPE	
LIST DATA INPUT	-0.00000		-0.00000
WRITE FINAL SUMMARY	-0.00000		-0.00000
FLOW AUGMENTATION	-0.00000		-0.00000
MODEL OPTION =	7.00000		-0.00000
NUMBER OF REACHES =	8.00000	NUMBER OF JUNCTIONS =	1.00000
NUM OF HEADWATERS =	2.00000	NUMBER OF WASTE LOADS =	4.00000
TIME STEP (HOURS) =	1.00000	LNTH. COMP. ELEMENT(MI) =	1.00000
MAXIMUM ROUTE TIME (HRS) =	240.00000	TIME INCR FOR RPT2 (HRS) =	240.00000
LATITUDE OF BASIN (DEG) =	29.50000	LONGITUDE OF BASIN (DEG) =	98.50000
STANDARD MERIDIAN (DEG) =	90.00000	DAY OF YEAR START TIME =	168.00000
EVAP. COEF.. (AE) =	.00068	EVAP. COEF.. (BE) =	.00027
ELEV. OF BASIN (FEET) =	725.00000	DUST ATTENUATION COEF. =	.04000
NO. OF CONS. TO ROUTE =	3.00000		-0.00000
ENDATA1	-0.00000		-0.00000

$$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$

CARD TYPE	REACH ORDER	AND IDENT		R. MILE		R. MILE
STREAM REACH	1	RCH = S A R SOURCE	FROM	232.0	TO	222.0
STREAM REACH	2	RCH = RILLING ROAD	FROM	222.0	TO	210.0
STREAM REACH	3	RCH = M R + LEON C	FROM	10.0	TO	0.0
STREAM REACH	4	RCH = ELMENDORF	FROM	210.0	TO	190.0
STREAM REACH	5	RCH = FLORESVILLE	FROM	190.0	TO	170.0
STREAM REACH	6	RCH = FLORE TO F C	FROM	170.0	TO	150.0
STREAM REACH	7	RCH = FALLS C-CIBO	FROM	150.0	TO	130.0
STREAM REACH	8	RCH = CIBOLO-RUNGE	FROM	130.0	TO	110.0
ENDATA2	-0			-0.0		-0.0

$$$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) $$$

CARD TYPE	REACH	AVAIL HDWS	TARGET	ORDER OF AVAIL SOURCES					
FLOW AUGMT. SOURCES	1	0	4.0	-0	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	2	0	4.0	-0	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	3	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	4	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	5	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	6	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT SOURCE	7	1	4.0	2	-0	-0	-0	-0	-0
FLOW AUGMT. SOURCES	8	1	4.0	2	-0	-0	-0	-0	-0
ENDATA3	-0	-0	-0.0	-0	-0	-0	-0	-0	-0

$$$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) $$$

CARD TYPE	REACH	ELEMENTS/REACH	COMPUTATIONAL FLAGS
FLAG FIELD	1	10	1 2 2 2 2 2 2 2 2 2-0-0-0-0-0-0-0-0-0-0
FLAG FIELD	2	12	2 2 6 2 2 2 2 2 2 2 2 3-0-0-0-0-0-0-0-0
FLAG FIELD	3	10	1 2 2 6 2 2 2 2 2 2-0-0-0-0-0-0-0-0-0-0
FLAG FIELD	4	20	4 2 2 2 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	5	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	6	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD	7	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 6 2
FLAG FIELD	8	20	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5
ENDATA4	-0	-0	-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0

$$$ DATA TYPE 5 (HYDRAULIC COEFFICIENTS FOR DETERMINING VELOCITY AND DEPTH) $$$

CARD TYPE	REACH	COEFQV	EXPOQV	COEFQH	EXPOQH	CMANN
HYDRAULICS	1	.333	.335	.511	.264	.035
HYDRAULICS	2	.333	.335	.511	.264	.035
HYDRAULICS	3	.256	.381	.299	.381	.035
HYDRAULICS	4	.105	.414	.440	.414	.035
HYDRAULICS	5	.105	.414	.440	.414	.035
HYDRAULICS	6	.105	.414	.440	.414	.035
HYDRAULICS	7	.142	.414	.440	.414	.035
HYDRAULICS	8	.142	.414	.440	.414	.035
ENDATA5	-0	-0.000	-0.000	-0.000	-0.000	-0.000

$$$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND REAERATION) $$$

CARD TYPE	REACH	K1	K3	K2OPT	K2	COEQK2	EXPQK2
REACT COEF	1	.32	0.00	2	7.70	0.000	0.000
REACT COEF	2	.32	0.00	2	10.20	0.000	0.000
REACT COEF	3	.32	0.00	2	7.30	0.000	0.000
REACT COEF	4	.32	0.00	2	1.50	0.000	0.000
REACT COEF	5	.25	0.00	2	1.00	0.000	0.000
REACT COEF	6	.25	0.00	2	1.00	0.000	0.000
REACT COEF	7	.20	0.00	2	1.00	0.000	0.000
REACT COEF	8	.05	0.00	2	1.00	0.000	0.000
ENDATA6	-0	-0.00	-0.00	-0	-0.00	-0.000	-0.000

$$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$

CARD TYPE	REACH	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
INITIAL CONDITIONS	1	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	2	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	3	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	4	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	5	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	6	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	7	81.4	6.0	1.0	0.0	0.0	0.0
INITIAL CONDITIONS	8	81.4	6.0	1.0	0.0	0.0	0.0
ENDATA7	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 8 (RUNOFF CONDITIONS) $$$

CARD TYPE	REACH	Q	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
RUNOFF CONDITIONS	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUNOFF CONDITIONS	5	15.0	81.4	8.0	2.0	185.3	119.0	840.0
RUNOFF CONDITIONS	6	15.0	81.4	8.0	2.0	453.3	383.3	1664.6
RUNOFF CONDITIONS	7	24.0	81.4	8.0	2.0	200.0	200.0	1000.0
RUNOFF CONDITIONS	8	24.0	81.4	8.0	2.0	170.0	170.0	800.0
ENDATA8	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$

CARD TYPE	JUNCTION ORDER AND IDENT		UPSTRM	DOWNSTRM	TRIB
STREAM JUNCTION	1	JNC = S.A.R. + M.R.	22	33	32
ENDATA9	-0		-0	-0	-0

$$$ DATA TYPE 10 (HEADWATER SOURCES) $$$

CARD TYPE	HDWATER ORDER AND IDENT		FLOW	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
HEADWATER	1	HDW = S.A.R. SOURCE	14.0	81.4	7.5	2.0	36.0	42.0	299.0
HEADWATER	2	HDW = MEDINA RIVER	60.6	78.8	7.5	1.0	34.4	11.7	234.8
ENDATA10	-0		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

$$$ DATA TYPE 11 (WASTE LOADINGS) $$$

CARD TYPE	WASTE LOAD ORDER AND IDENT		EFF	FLOW	TEMP	D.O.	BOD	CM-I	CM-II	CM-III
WASTE LOAD	1	WSL = RILLING STP	0.00	97.0	82.4	7.0	38.0	132.0	139.8	764.9
WASTE LOAD	2	WSL = LEON CRK STP	0.00	17.4	78.8	7.5	35.0	113.0	134.0	760.0
WASTE LOAD	3	WSL = BRAU+CALAVER	1.00	-64.0	0.0	0.0	0.0	0.0	0.0	0.0
WASTE LOAD	4	WSL = CIBO CRK TRB	0.00	28.0	81.4	8.0	1.6	242.0	169.0	833.0
ENDATA11	-0		-0.00	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

EXAMPLE OF INTERMEDIATE SUMMARY FOR ONE DAY

CONSERVATIVE MINERAL I (MG/L X 10) = SULFATE AFTER 10.00 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6										
2	3.6	3.6	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0								
3	3.4	3.4	3.4	5.2	5.2	5.2	5.2	5.2	5.2	5.2										
4	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
5	9.2	9.3	9.3	9.4	9.5	9.5	9.6	9.6	9.7	9.7	9.8	9.8	9.9	9.9	10.0	10.0	10.0	10.1	10.1	10.2
6	10.4	10.6	10.7	10.9	11.1	11.3	11.5	11.6	11.8	12.0	12.1	12.3	12.5	12.6	12.8	13.0	13.1	13.3	13.4	13.6
7	13.6	13.7	13.7	13.8	13.8	13.9	13.9	14.0	14.0	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.3	14.4	15.7	15.8
8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.9	15.9	15.9	15.9	15.9	15.9	15.9

CONSERVATIVE MINERAL II (MG/L X 10) = CHLORIDE AFTER 10.00 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2										
2	4.2	4.2	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7								
3	1.2	1.2	1.2	3.9	3.9	3.9	3.9	3.9	3.9	3.9										
4	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
5	9.1	9.1	9.1	9.2	9.2	9.2	9.2	9.2	9.2	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.4	9.4	9.4	9.4
6	9.5	9.7	9.8	10.0	10.1	10.3	10.4	10.6	10.7	10.9	11.0	11.1	11.3	11.4	11.5	11.7	11.8	11.9	12.1	12.2
7	12.3	12.3	12.4	12.4	12.5	12.5	12.6	12.6	12.7	12.8	12.8	12.9	12.9	13.0	13.0	13.1	13.1	13.1	13.7	13.7
8	13.8	13.8	13.8	13.8	13.8	13.8	13.9	13.9	13.9	13.9	13.9	13.9	14.0	14.0	14.0	14.0	14.0	14.0	14.1	14.1

CONSERVATIVE MINERAL III (MG/L X 10) = T. D. S. AFTER 10.00 DAYS

RCH/CL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9										
2	29.9	29.9	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6								
3	23.5	23.5	23.5	35.2	35.2	35.2	35.2	35.2	35.2	35.2										
4	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
5	56.1	56.3	56.5	56.6	56.8	56.9	57.1	57.3	57.4	57.6	57.7	57.9	58.0	58.1	58.3	58.4	58.6	58.7	58.8	59.0
6	59.6	60.1	60.7	61.2	61.8	62.3	62.9	63.4	63.9	64.4	65.0	65.5	66.0	66.5	67.0	67.5	67.9	68.4	68.9	69.4
7	69.6	69.8	70.1	70.3	70.5	70.7	71.0	71.2	71.4	71.6	71.8	72.0	72.2	72.4	72.6	72.8	72.9	73.1	74.7	74.8
8	74.8	74.9	74.9	74.9	75.0	75.0	75.0	75.0	75.1	75.1	75.1	75.1	75.2	75.2	75.2	75.2	75.3	75.3	75.3	75.3

EXAMPLE OF FINAL SUMMARY FOR ONE REACH

* * * FINAL REPORT * * *

REACH NO. 2 (RCH = RILLING ROAD)

PARAMETER		HEAD OF REACH	END OF REACH	MAXIMUM	MINIMUM	AVERAGE
RIVER MILE	=	222.0	210.0			
FLOW (CFS)	=	14.000	111.000	111.000	14.000	94.833
VELOCITY (FPS)	=	.806	1.613	1.613	.806	1.530
DEPTH (FT)	=	1.026	1.772	1.772	1.026	1.700
K1 (1/DAY)	=	.320	.320	.320	.320	.320
K2 (1/DAY)	=	0.000	0.000	0.000	0.000	0.000
K3 (1/DAY)	=	0.000	0.000	0.000	0.000	0.000
TEMP (F)	=	81.400	81.400	81.400	81.400	81.400
BOD (MG/L)	=	1.000	1.000	1.000	1.000	1.000
DO (MG/L)	=	6.000	6.000	6.000	6.000	6.000
CONS ONE (MG/L)	=	36.000	119.883	119.889	36.000	105.908
CONS TWO (MG/L)	=	42.000	127.454	127.462	42.000	113.219
CONS THREE (MG/L)	=	299.000	706.091	706.126	299.000	638.274

V. QUAL-I PROGRAM LISTING

MAIN PROGRAM - QMODEL

```
C
C                                     QMODEL IS A SET OF INTERRELATED STREAM
C                                     QUALITY ROUTING MODELS. IT HAS THE
C                                     CAPABILITY TO ROUTE TEMP., BOD/DO, AND
C                                     UP TO THREE CONSERVATIVE MINERALS
C                                     THROUGH A FULLY-MIXED STREAM SYSTEM.
C                                     THESE PARAMETERS CAN BE ROUTED ON AN
C                                     INDIVIDUAL BASIS OR SIMULTANEOUSLY IN
C                                     SUCH A COMBINATION AS THE USER MAY
C                                     DESIRE. QMODEL ALSO HAS THE CAPABILITY
C                                     TO COMPUTE THE FLOW AUGMENTATION REQ'D.
C                                     TO MEET PRESELECTED MINIMUM DO LEVELS.
C                                     HYDRAULICS ARE CONSIDERED STEADY-STATE.

      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K20PT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTQVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      DIMENSION DATA(25,50),CODE(13)
      REAL K1,K2,LAT,LLM,LSM,JUNCID

C                                     STEP 1-0
C                                     INITIALIZE CERTAIN PARAMETERS

      ILIST=0
      IRPT1=0
      IAUGOP =0
      LAT=0.0
      LLM=0.0
      LSM=0.0
      DAYOFY=0.0
      AF=0.0
      BF=0.0
      ELEV=0.0
      DAT=0.0
      NERROR=0
      TIME=0.0
      TPRINT=0.0
      TOFDAY=0.0
      TRLCD=0.0
      NI=5
      NJ=6
      DATA ENDT/4HENDT/ , ENDA/4HENDA/
      DATA CODE/4HLIST,4HWRIT,4HFLOW,4HMODE,4HNUMB,4HNUM ,4HTIME,
     *          4HMAXI,4HLATI,4HSTAN,4HEVAP,4HELEV,4HNO. /

C
C                                     STEP 2-0
C                                     READ IN TITLES
C
      DO 30 I=1,9
      READ (NI,31) (TITLE(I,J),J=1,20)
   31 FORMAT (20A4)
      IF (TITLE(I,1)-ENDT) 30,35,30
   30 CONTINUE
      NERROR=1
   34 I=I+1
      READ (NI,31) (TITLE(I,J),J=1,20)
      IF (TITLE(I,1)-ENDT)34,39,34
   39 N=I-9
      WRITE (NJ,32) N
   32 FORMAT (1HO,5X,16H***** TOO MANY (,I3,18H) TITLE CARDS READ)
      GO TO 33
   35 IF (I.GE.9) GO TO 33
      NERROR=1
      N=9-I
      WRITE (NJ,36) N
   36 FORMAT (1HO,5X,15H***** TOO FEW (,I3,18H) TITLE CARDS READ)
   33 CONTINUE
      NTITLE=I

C                                     STEP 3-0
C                                     READ IN ALL DATA REQUIRED FOR OPERATION
C                                     OF THE MODELS.
C
C                                     STEP 3-1
C                                     READ IN DATA TYPE 1 (MODEL CONTROL DATA)
C
      DO 20 I=1,14
      READ (NI,21) (DATA(I,K),K=1,16)
   21 FORMAT (6A4,A1,F10.0,10X,6A4,A1,F10.0)
      IF (DATA(I,1)-ENDA)20,25,20
   20 CONTINUE
      NERROR=1
   24 I=I+1
      READ (NI,21) (DATA(I,K),K=1,16)
      IF (DATA(I,1)-ENDA)24,29,24
   29 N=I-14
      WRITE (NJ,22) N
   22 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA1 CARDS READ)
      GO TO 23
   25 IF (I.GE.14) GO TO 23
      NERROR=1
      N=14-I
      WRITE (NJ,26) N
   26 FORMAT (1HO,5X,15H***** TOO FEW (,I3,18H) DATA1 CARDS READ)
   23 CONTINUE
      N=I-1
      NCRDS = I
      DO 16 I=1,N
      DO 16 J=1,13
      IF (DATA(I,1)-CODE(J)) 16,4,16
    4 GO TO (5,6,7,8,9,10,11,12,13,14,15,18,19), J
```

```
    5 ILIST = 1
      GO TO 16
    6 IRPTI = 1
      GO TO 16
    7 IAUGOP = 1
      GO TO 16
    8 MODOPT = DATA(I,8)
      GO TO 16
    9 NREACH = DATA(I,8)
      NJUNC = DATA(I,16)
      GO TO 16
   10 NHWTRS = DATA(I,8)
      NWASTE = DATA(I,16)
      GO TO 16
   11 DFLT = DATA(I,8)
      DFLX = DATA(I,16)
      GO TO 16
   12 TMAX = DATA(I,8)
      PTIME = DATA(I,16)
      GO TO 16
   13 LAT = DATA(I,8)
      LLM = DATA(I,16)
      GO TO 16
   14 LSH = DATA(I,8)
      DAYOFY = DATA(I,16)
      GO TO 16
   15 AF = DATA(I,8)
      BF = DATA(I,16)
      GO TO 16
   18 ELEV=DATA(I,8)
      DAT=DATA(I,16)
      GO TO 16
   19 NCS=DATA(I,8)
   16 CONTINUE
      IF (ILIST.EQ.0) GO TO 200
      WRITE (NJ,501)
  501 FORMAT (1H1,35X,29HTEXAS WATER DEVELOPMENT BOARD,/
     *            22X,42H* * * DATA LIST FOR STREAM QUALITY ROUTING,
     *                12H MODEL * * *)
      WRITE (NJ,502)
  502 FORMAT (1H0,10X,24H$$$ (PROBLEM TITLES) $$$,/)
      WRITE (NJ,201)
  201 FORMAT (10X,9HCARD TYPE,29X,21HQUAL-I PROGRAM TITLES)
      WRITE (NJ,503) ((TITLE(I,J),J=1,20),I=1,NTITLE)
  503 FORMAT (10X,20A4)
      WRITE (NJ,504)
  504 FORMAT (1H0,10X,34H$$$ DATA TYPE 1 (CONTROL DATA) $$$,/)
      WRITE (NJ,203)
  203 FORMAT (10X,9HCARD TYPE,36X,9HCARD TYPE)
      WRITE (NJ,103) ((DATA(I,J),J=1,16),I=1,NCRDS)
  103 FORMAT (2(10X,6A4,A1,F10.5))
  200 CONTINUE
C
C                                     STEP 3-2
C                                     READ IN DATA TYPE 2 (REACH IDENT. AND
C                                     RIVER MILE AT HEAD AND END OF REACH).
C
C
```



```
      II = NREACH+1
      DO 50 I=1,II
      READ (NI,51) (DATA(I,J),J=1,13)
   51 FORMAT (3A4,3X,F5.0,5A4,3X,A4,3X,F10.0,4X,A2,4X,F10.0)
      IF (DATA(I,1)-ENDA) 50,55,50
   50 CONTINUE
      NERROR=1
   54 I=I+1
      READ (NI,51) (DATA(I,J),J=1,13)
      IF (DATA(I,1)-ENDA) 54,59,54
   59 N=I-II
      WRITE (NJ,52) N
   52 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA2 CARDS READ)
      GO TO 53
   55 IF (I.GE.II) GO TO 53
      NERROR = 1
      N=II-I
      WRITE (NJ,56) N
   56 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA2 CARDS READ)
   53 CONTINUE
      NCRDS=I
      DO 57 I=1,NREACH
      NRCH = DATA(I,4)
      DO 58 J=5,9
      K = J-4
      RCHID(NRCH,K) = DATA(I,J)
   58 CONTINUE
      RMTHOR(NRCH) = DATA(I,11)
      RMTEOR(NRCH) = DATA(I,13)
   57 CONTINUE
      IF (ILIST.EQ.0) GO TO 425
      WRITE (NJ,505)
  505 FORMAT (1H0,10X,42H$$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$,/)
      WRITE (NJ,205)
  205 FORMAT (10X,9HCARD TYPE,11X,21HREACH ORDER AND IDENT,
     *        15X,7HR. MILE,13X,7HR. MILE)
      WRITE (NJ,401) ((DATA(I,J),J=1,13),I=1,NCRDS)
  401 FORMAT (10X,3A4,3X,F5.0,2X,5A4,3X,A4,3X,F10.1,4X,A2,4X,F10.1)
  425 CONTINUE
C
C                                     STEP 3-3
C                                     READ IN DATA TYPE 3 (TARGET LEVEL DO AND
C                                     AVAILABLE FLOW AUGMENTATION SOURCES).
C
C
      DO 60 I=1,II
      READ (NI,61) (DATA(I,J),J=1,14)
   61 FORMAT (5A4,5X,F5.0,5X,F5.0,F10.0,6F5.0)
      IF (DATA(I,1)-ENDA) 60,65,60
   60 CONTINUE
      NERROR = 1
   64 I=I+1
      READ (NI,61) (DATA(I,J),J=1,14)
      IF (DATA(I,1)-ENDA) 64,69,64
   69 N=I-II
      WRITE (NJ,62) N
   62 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA3 CARDS READ)
      GO TO 63
```

```
 65 IF (I.GE.II) GO TO 63
    NERROR = 1
    N=II-I
    WRITE (NJ,66) N
 66 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA3 CARDS READ)
 63 CONTINUE
    NCRDS=I
    DO 67 I=1,NREACH
    NRCH = DATA(I,6)
    NHWAR = DATA(I,7)
    NHWWAR(NRCH) = NHWAR
    TARGDO(NRCH)=DATA(I,8)
    DO 68 J=9,14
    K = J-8
    IAUGOR(NRCH,K) = DATA(I,J)
 68 CONTINUE
 67 CONTINUE
    IF (ILIST.EQ.0) GO TO 426
    WRITE (NJ,506)
506 FORMAT (1H0,10X,36H$$$ DATA TYPE 3 (TARGET LEVEL DO AND,
   *               31H FLOW AUGMENTATION SOURCES) $$$,/)
    WRITE (NJ,206)
206 FORMAT (10X,9HCARD TYPE,18X,24HREACH  AVAIL HDWS TARGET,
   *        5X,22HORDER OF AVAIL SOURCES)
    WRITE (NJ,402) ((DATA(I,J),J=1,14),I=1,NCRDS)
402 FORMAT (10X,5A4,5X,F5.0,5X,F5.0,F10.1,6F5.0)
426 CONTINUE
C
C                                   STEP 3-4
C                                   READ IN DATA TYPE 4 (COMPUTATIONAL
C                                   ELEMENT FLAG FIELD)
C                                       1  =  ELEMENT WHICH REPRESENTS A
C                                             HEADWATER SOURCE.
C                                       2  =  AN ELEMENT WITH NO EXTERNAL
C                                             INPUTS OTHER THAN INCREMENTAL.
C                                       3  =  AN ELEMENT ON THE MAINSTREAM
C                                             IMMEDIATELY UPSTREAM FROM A
C                                             JUNCTION.
C                                       4  =  AN ELEMENT WHICH REPRESENTS
C                                             A STREAM JUNCTION.
C                                       5  =  AN ELEMENT WHICH REPRESENTS
C                                             THE LAST COMPUTATIONAL ELEMENT
C                                             IN THE SYSTEM.
C                                       6  =  AN ELEMENT WITH A WASTE INPUT.
C                                       7  =  AN ELEMENT WITH A WITHDRAWL.
C
    DO 70 I=1,II
    READ (NI,71) (DATA(I,J),J=1,25)
 71 FORMAT (2A4,A2,5X,F5.0,5X,F5.0,10X,20F2.0)
    IF (DATA(I,1)-ENDA) 70,75,70
 70 CONTINUE
    NERROR=1
 74 I=I+1
    READ (NI,71) (DATA(I,J),J=1,25)
    IF (DATA(I,1)-ENDA) 74,79,74
 79 N=I-II
    WRITE (NJ,72) N
 72 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA4 CARDS READ)
    GO TO 73
 75 IF (I.GE.II) GO TO 73
    NERROR = 1
    N=II-I
    WRITE (NJ,76) N
 76 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA4 CARDS READ)
 73 CONTINUE
    NCRDS=I
    DO 77 I=1,NREACH
    NRCH = DATA(I,4)
    NCELR = DATA(I,5)
    NCELRH(NRCH)=NCELR
    DO 78 J=6,25
    K = J-5
    IFLAG(NRCH,K)=DATA(I,J)
 78 CONTINUE
 77 CONTINUE
    IF (ILIST.EQ.0) GO TO 427
    WRITE (NJ,507)
507 FORMAT (1H0,10X,36H$$$ DATA TYPE 4 (COMPUTATIONAL REACH,
   *               16H FLAG FIELD) $$$,/)
    WRITE (NJ,207)
207 FORMAT (10X,9HCARD TYPE,8X,20HREACH ELEMENTS/REACH,
   *        13X,19HCOMPUTATIONAL FLAGS)
    WRITE (NJ,403) ((DATA(I,J),J=1,25),I=1,NCRDS)
403 FORMAT (10X,2A4,A2,5X,F5.0,5X,F5.0,10X,20F2.0)
427 CONTINUE
    IOR=0
    DO 28 I=1,NREACH
    NCELR=NCELRH(I)
    DO 28 J=1,NCELR
    IOR=IOR+1
    IFLORD(I,J)=IOR
 28 CONTINUE
    NCELLS=IOR
C
C                                   STEP 3-5
C                                   READ IN DATA TYPE 5 (HYDRAULIC COEF.
C                                   FOR COMPUTING VELOCITY AND DEPTH).
C
    DO 80 I=1,II
    READ (NI,81) (DATA(I,J),J=1,9)
 81 FORMAT (2A4,A2,5X,F5.0,10X,5F10.0)
    IF (DATA(I,1)-ENDA) 80,85,80
 80 CONTINUE
    NERROR = 1
 84 I=I+1
    READ (NI,81) (DATA(I,J),J=1,9)
    IF (DATA(I,1)-ENDA) 84,89,84
 89 N=I-II
    WRITE (NJ,82) N
```

```
 82 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA5 CARDS READ)
    GO TO 83
 85 IF (I.GE.II) GO TO 83
    NERROR = 1
    N=II-I
    WRITE (NJ,86) N
 86 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA5 CARDS READ)
 83 CONTINUE
    NCRDS=I
    DO 87 I=1,NREACH
    NRCH = DATA(I,4)
    COEFQV(NRCH) = DATA(I,5)
    EXPOQV(NRCH) = DATA(I,6)
    COEFQH(NRCH) = DATA(I,7)
    EXPOQH(NRCH) = DATA(I,8)
    CHANN(NRCH) = DATA(I,9)
 87 CONTINUE
    IF (ILIST.EQ.0) GO TO 428
    WRITE (NJ,508)
508 FORMAT (1H0,10X,39H$$$ DATA TYPE 5 (HYDRAULIC COEFFICIENTS,
   *                40H FOR DETERMINING VELOCITY AND DEPTH) $$$,/)
    WRITE (NJ,208)
208 FORMAT (10X,9HCARD TYPE,8X,5HREACH,13X,16HCOEFQV    EXPOQV,
   *        4X,26HCOEFQH    EXPOQH      CHANN)
    WRITE (NJ,404) ((DATA(I,J),J=1, 9),I=1,NCRDS)
404 FORMAT (10X,2A4,A2,5X,F5.0,10X,5F10.3)
428 CONTINUE
C
C                                   STEP 3-6
C                                   READ IN DATA TYPE 6 (REACTION COEF. FOR
C                                   DEOXYGENATION AND REAERATION).
C
C
C
    DO 90 I=1,II
    READ (NI,91) (DATA(I,J),J=1,10)
 91 FORMAT (2A4,A2,5X,F5.0,6F10.0)
    IF (DATA(I,1)-ENDA) 90,95,90
 90 CONTINUE
    NERROR = 1
 94 I=I+1
    READ (NI,91) (DATA(I,J),J=1,10)
    IF (DATA(I,1)-ENDA) 94,99,94
 99 N=I-II
    WRITE (NJ,92) N
 92 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA6 CARDS READ)
    GO TO 93
 95 IF (I.GE.II) GO TO 93
    NERROR = 1
    N=II-I
    WRITE (NJ,96) N
 96 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA6 CARDS READ)
 93 CONTINUE
    NCRDS=I
    DO 97 I=1,NREACH
    NRCH = DATA(I,4)
    CK1(NRCH) = DATA(I,5)
    CK3(NRCH) = DATA(I,6)
    K20PT(NRCH) = DATA(I,7)
    CK2(NRCH) = DATA(I,8)
    COEQK2(NRCH) = DATA(I,9)
    EXPQK2(NRCH) = DATA(I,10)
 97 CONTINUE
    IF (ILIST.EQ.0) GO TO 429
    WRITE (NJ,509)
509 FORMAT (1H0,10X,38H$$$ DATA TYPE 6 (REACTION COEFFICIENTS,
   *                38H FOR DEOXYGENATION AND REAERATION) $$$,/)
    WRITE (NJ,209)
209 FORMAT (10X,9HCARD TYPE,8X,12HREACH     K1,8X,2HK3,8X,5HK20PT,
   *        5X,23HK2      COEQK2    EXPQK2)
    WRITE (NJ,405) ((DATA(I,J),J=1,10),I=1,NCRDS)
405 FORMAT (10X,2A4,A2,5X,F5.0,2F10.2,F10.0,F10.2,2F10.3)
429 CONTINUE
C
C                                   STEP 3-7
C                                   READ IN DATA TYPE 7 (INITIAL CONDITIONS)
C
C
    DO 110 I=1,II
    READ (NI,111) (DATA(I,J),J=1,12)
111 FORMAT (5A4,5X,F5.0,F10.0,2F5.0,3F10.0)
    IF (DATA(I,1)-ENDA) 110,115,110
110 CONTINUE
    NERROR=1
114 I=I+1
    READ (NI,111) (DATA(I,J),J=1,12)
    IF (DATA(I,1)-ENDA) 114,119,114
119 N=I-II
    WRITE (NJ,112) N
112 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA7 CARDS READ)
    GO TO 113
115 IF (I.GE.II) GO TO 113
    NERROR = 1
    N=II-I
    WRITE (NJ,116) N
116 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA7 CARDS READ)
113 CONTINUE
    NCRDS=I
    DO 117 I=1,NREACH
    NRCH = DATA(I,6)
    TINIT(NRCH) = DATA(I,7)
    DOINIT(NRCH) = DATA(I,8)
    BOINIT(NRCH) = DATA(I,9)
    COINIT(NRCH,1)=DATA(I,10)
    COINIT(NRCH,2)=DATA(I,11)
    COINIT(NRCH,3)=DATA(I,12)
117 CONTINUE
    IF (ILIST.EQ.0) GO TO 430
    WRITE (NJ,510)
510 FORMAT (1H0,10X,40H$$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$,/)
    WRITE (NJ,210)
210 FORMAT (10X,9HCARD TYPE,18X,23HREACH    TEMP  D.O.  BOD,
   *        6X,26HCM-I      CM-II     CM-III)
    WRITE (NJ,406) ((DATA(I,J),J=1,12),I=1,NCRDS)
406 FORMAT (10X,5A4,5X,F5.0,F10.1,2F5.1,3F10.1)
430 CONTINUE
C
```

```
C                                       STEP 3-8
C                                       READ IN DATA TYPE 8 (INCREMENTAL FLOW
C                                       CONDITIONS).
C
      DO 120 I=1,II
      READ (NI,121) (DATA(I,J),J=1,13)
  121 FORMAT (5A4,5X,5F5.0,3F10.0)
      IF (DATA(I,1)-ENDA) 120,125,120
  120 CONTINUE
      NERROR=1
  124 I=I+1
      READ (NI,121) (DATA(I,J),J=1,13)
      IF (DATA(I,1)-ENDA) 124,129,124
  129 N=I-II
      WRITE (NJ,122) N
  122 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA8 CARDS READ)
      GO TO 123
  125 IF (I.GE.II) GO TO 123
      NERROR = 1
      N=II-I
      WRITE (NJ,126) N
  126 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA8 CARDS READ)
  123 CONTINUE
      NCRDS=I
      DO 127 I=1,NREACH
      NRCH = DATA(I,6)
      QI(NRCH) = DATA(I,7)
      TI(NRCH) = DATA(I,8)
      DOI(NRCH) = DATA(I,9)
      BODI(NRCH) = DATA(I,10)
      CONSI(NRCH,1)=DATA(I,11)
      CONSI(NRCH,2)=DATA(I,12)
      CONSI(NRCH,3)=DATA(I,13)
  127 CONTINUE
      IF (ILIST.EQ.0) GO TO 431
      WRITE (NJ,511)
  511 FORMAT (1H0,10X,39H$$$ DATA TYPE 8 (RUNOFF CONDITIONS) $$$,/)
      WRITE (NJ,211)
  211 FORMAT (10X,9HCARD TYPE,18X,23HREACH Q  TEMP  D.O. BOD,
     *        6X,26HCM-I      CM-II     CM-III)
      WRITE (NJ,407) ((DATA(I,J),J=1,13),I=1,NCRDS)
  407 FORMAT (10X,5A4,5X,F5.0,4F5.1,3F10.1)
  431 CONTINUE
C
C                                       STEP 3-9
C                                       READ IN DATA TYPE 9 (STREAM JUNCTION
C                                       IDENTIFICATION AND THE ORDER OF THE
C                                       CONNECTING ELEMENTS TAKEN CLOCKWISE
C                                       AROUND THE JUNCTION).
C
      II=NJUNC+1
      DO 130 I=1,II
      READ (NI,131) (DATA(I,J),J=1,13)
  131 FORMAT (3A4,A3,5X,F5.0,5X,5A4,3(5X,F5.0))
      IF (DATA(I,1)-ENDA) 130,135,130
  130 CONTINUE
      NERROR=1
  134 I=I+1
      READ (NI,131) (DATA(I,J),J=1,13)
      IF (DATA(I,1)-ENDA) 134,139,134
  139 N=I-II
      WRITE (NJ,132) N
  132 FORMAT (1H0,5X,16H***** TOO MANY (,I3,18H) DATA9 CARDS READ)
      GO TO 133
  135 IF (I.GE.II) GO TO 133
      NERROR = 1
      N=II-I
      WRITE (NJ,136) N
  136 FORMAT (1H0,5X,15H***** TOO FEW (,I3,18H) DATA9 CARDS READ)
  133 CONTINUE
      NCRDS=I
      DO 137 I=1,NJUNC
      IJUNC = DATA(I,5)
      DO 138 J=6,10
      K = J-5
      JUNCID(IJUNC,K)=DATA(I,J)
  138 CONTINUE
      JUNC(IJUNC,1) = DATA(I,11)
      JUNC(IJUNC,2) = DATA(I,12)
      JUNC(IJUNC,3) = DATA(I,13)
  137 CONTINUE
      IF (ILIST.EQ.0) GO TO 432
      WRITE (NJ,512)
  512 FORMAT (1H0,10X,38H$$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$,/)
      WRITE (NJ,212)
  212 FORMAT (10X,9HCARD TYPE,14X,24HJUNCTION ORDER AND IDENT,
     *        9X,25HUPSTRM   DOWNSTRM    TRIB)
      WRITE (NJ,408) ((DATA(I,J),J=1,13),I=1,NCRDS)
  408 FORMAT (10X,3A4,A3,5X,F5.0,5X,5A4,5X,F5.0,5X,F5.0,5X,F5.0)
  432 CONTINUE
C
C                                       STEP 3-10
C                                       READ IN DATA TYPE 10 (HEADWATER SOURCES
C                                       AND THEIR CHARACTERISTICS).
C
      II = NHWTRS+1
      DO 140 I=1,II
      READ (NI,141) (DATA(I,J),J=1,16)
  141 FORMAT (2A4,A2,5X,F5.0,5A4,F10.0,6F5.0)
      IF (DATA(I,1)-ENDA) 140,145,140
  140 CONTINUE
      NERROR=1
  144 I=I+1
      READ (NI,141) (DATA(I,J),J=1,16)
      IF (DATA(I,1)-ENDA) 144,149,144
  149 N=I-II
      WRITE (NJ,142) N
  142 FORMAT (1H0,5X,16H***** TOO MANY (I3,19H) DATA10 CARDS READ)
      GO TO 143
  145 IF (I.GE.II) GO TO 143
      NERROR = 1
      N=II-I
      WRITE (NJ,146) N
  146 FORMAT (1H0,5X,15H***** TOO FEW (,I3,19H) DATA10 CARDS READ)
```

```
  143 CONTINUE
      NCRDS=I
      DO 147 I=1,NHWTRS
      NHW = DATA(I,4)
      DO 148 J=5,9
      K = J-4
      HWTRID(NHW,K) = DATA(I,J)
  148 CONTINUE
      HWFLOW(NHW) = DATA(I,10)
      HWTEMP(NHW) = DATA(I,11)
      HWDO(NHW) = DATA(I,12)
      HWBOD(NHW) = DATA(I,13)
      HWCONS(NHW,1)=DATA(I,14)
      HWCONS(NHW,2)=DATA(I,15)
      HWCONS(NHW,3)=DATA(I,16)
      QATOT(NHW)=HWFLOW(NHW)
  147 CONTINUE
      IF (ILIST.EQ.0) GO TO 433
      WRITE (NJ,513)
  513 FORMAT (1H0,10X,40HSSS DATA TYPE 10 (HEADWATER SOURCES) SSS,/)
      WRITE (NJ,213)
  213 FORMAT (10X,9HCARD TYPE,10X,23HHDWATER ORDER AND IDENT,
     *        6X,4IHFLOW  TEMP  D.O.   BOD CH-I  CH-II CH-III)
      WRITE (NJ,409) ((DATA(I,J),J=1,16),I=1,NCRDS)
  409 FORMAT (10X,2A4,A2,5X,F5.0,2X,5A4,F10.1,6F6.1)
  433 CONTINUE
C
C                                     STEP 3-II
C                                     READ IN DATA TYPE II (WASTE INPUTS AND
C                                     WITHDRAWLS AND THEIR CHARACTERISTICS).
C
      II = NWASTE+1
      DO 150 I=1,II
      READ (NI,151) (DATA(I,J),J=1,17)
  151 FORMAT (2A4,A2,F5.0,5A4,F5.0,F10.0,6F5.0)
      IF (DATA(I,1)-ENDA) 150,155,150
  150 CONTINUE
      NERROR=1
  154 I=I+1
      READ (NI,151) (DATA(I,J),J=1,17)
      IF (DATA(I,1)-ENDA) 154,159,154
  159 N=I-II
      WRITE (NJ,152) N
  152 FORMAT (1H0,5X,16H***** TOO MANY (,I3,19H) DATAII CARDS READ)
      GO TO 153
  155 IF (I.GE.II) GO TO 153
      NERROR = 1
      N=II-1
      WRITE (NJ,156) N
  156 FORMAT (1H0,5X,15H***** TOO FEW (,I3,19H) DATAII CARDS READ)
  153 CONTINUE
      NCRDS=I
      DO 157 I=1,NWASTE
      NWS = DATA(I,4)
      DO 158 J=5,9
      K = J-4
      WASTID(NWS,K)=DATA(I,J)
  158 CONTINUE
      WFACT(NWS) = DATA(I,10)
      WSFLOW(NWS) = DATA(I,11)
      WSTEMP(NWS) = DATA(I,12)
      WSDO(NWS) = DATA(I,13)
      WSBOD(NWS) = DATA(I,14)
      WSCONS(NWS,1)=DATA(I,15)
      WSCONS(NWS,2)=DATA(I,16)
      WSCONS(NWS,3)=DATA(I,17)
  157 CONTINUE
      IF (ILIST.EQ.0) GO TO 434
      WRITE (NJ,514)
  514 FORMAT (1H0,10X,37HSSS DATA TYPE II (WASTE LOADINGS) SSS,/)
      WRITE (NJ,214)
  214 FORMAT (10X,9HCARD TYPE,2X,31HWASTE LOAD ORDER AND IDENT  EFF,
     *        6X,4IHFLOW  TEMP  D.O.   BOD CH-I  CH-II CH-III)
      WRITE (NJ,410) ((DATA(I,J),J=1,17),I=1,NCRDS)
  410 FORMAT (10X,2A4,A2,F5.0,2X,5A4,F5.2,F10.1,6F6.1)
  434 CONTINUE
      WRITE (NJ,2055)
 2055 FORMAT (1H1)
C
C                                     STEP 4-0
C                                     IF THE CORRECT NO. OF DATA CARDS HAS
C                                     NOT BEEN READ IN, THE PROGRAM WILL
C                                     TERMINATE.
C
      IF (NERROR.EQ.0) GO TO 888
      WRITE (NJ,2066)
 2066 FORMAT (1H1,15X,34H* * * * * * * * * * * * * * * * * *,
     *            33H* * * * * * * * * * * * * * * * * *,//,
     *         16X,34H* E X E C U T I O N  W A S  T E ,
     *            33HR M I N A T E D  B E C A U S E *,//,
     *         16X, 1H*,31X,3HO F,31X,1H*,//,
     *         16X,34H*           E R R O R S  I N  ,
     *            33HI N P U T  D A T A             *,//,
     *         16X,34H* * * * * * * * * * * * * * * * *,
     *            33H* * * * * * * * * * * * * * * * * *)
      GO TO 9999
  888 CONTINUE
C
C                                     STEP 5-0
C                                     ESTABLISH REQUIRED CONSTANTS.
C
      DFLX=DELX*5280.0
      D1LT=DELT/24.0
      D2LT=DELT
      DFLT=DELT*3600.0
      TMAX=TMAX-0.01
      DTODX2=DELT/(DELX*DELX)
      DT2ODX=2.0*DELT/DELX
C
C                                     STEP 6-0
C                                     SET INITIAL CONDITIONS.
C
      DO 915 I=1,NREACH
      NCELR=NCELRH(I)
```

```
      DO 915 J=1,NCELR
      IOR=ICLORD(I,J)
      T(IOR)=TINIT(I)
      DO(IOR)=DOINIT(I)
      BOD(IOR)=BOINIT(I)
      CONS(IOR,1)=COINIT(I,1)
      CONS(IOR,2)=COINIT(I,2)
      CONS(IOR,3)=COINIT(I,3)
  915 CONTINUE
      DO 922 NWS=1,NWASTE
      EFLBOD=1.0-TRFACT(NWS)
      WSBOD(NWS)=EFLBOD*WSBOD(NWS)
  922 CONTINUE
C
C                                   STEP 7-0
C                                   BEGIN COMPUTATIONS AND OPERATE UNTIL
C                                   STEADY-STATE CONDITIONS ARE REACHED.
C                                   WHICH IS THE TIME (TMAX) REQUIRED FOR A
C                                   WATER PARTICLE AT THE UPPERMOST POINT
C                                   IN THE SYSTEM TO REACH THE END OF
C                                   THE SYSTEM.
C
C                                   STEP 7-1
C                                   CALL SUBROUTINES TO PERFORM HYDROLOGIC
C                                   BALANCE ON SYSTEM AND ESTABLISH
C                                   COEFFICIENT MATRIX.
C
  998 CALL HYDRAU
      CALL TRIMAT
  999 TIME=TIME+D2LT
      TPRINT=TPRINT+D2LT
C
C                                   STEP 7-2
C                                   ROUTE SELECTED QUALITY PARAMETERS.
C
C                                        MODOPT = 1     TEMP + BOD/DO + CONS
C                                        MODOPT = 2     TEMP + BOD/DO
C                                        MODOPT = 3     BOD/DO
C                                        MODOPT = 4     CONS + TEMP
C                                        MODOPT = 5     TEMP
C                                        MODOPT = 6     BOD/DO + CONS
C                                        MODOPT = 7     CONS
C
      GO TO (701,702,703,704,705,706,707), MODOPT
  701 NT=3
      DO 777 NC=1,NCS
      CALL CONSVT
      CALL SOVMAT
      NT=NT+1
      DO 808 I=1,NCELLS
      CONS(I,NC)=Z(I)
  808 CONTINUE
  777 CONTINUE
  702 NT=6
      CALL TEMPS
      CALL SOVMAT
      DO 800 I=1,NCELLS
      T(I)=Z(I)
  800 CONTINUE
  703 NT=7
      CALL BODS
      CALL SOVMAT
      DO 802 I=1,NCELLS
      BOD(I)=Z(I)
  802 CONTINUE
      NT=8
      CALL REAERC
      CALL DOS
      CALL SOVMAT
      DO 803 I=1,NCELLS
      DO(I)=Z(I)
  803 CONTINUE
      GO TO 799
  704 NT=3
      DO 778 NC=1,NCS
      CALL CONSVT
      CALL SOVMAT
      NT=NT+1
      DO 809 I=1,NCELLS
      CONS(I,NC)=Z(I)
  809 CONTINUE
  778 CONTINUE
  705 NT=6
      CALL TEMPS
      CALL SOVMAT
      DO 810 I=1,NCELLS
      T(I)=Z(I)
  810 CONTINUE
      GO TO 799
  706 NT=7
      CALL BODS
      CALL SOVMAT
      DO 812 I=1,NCELLS
      BOD(I)=Z(I)
  812 CONTINUE
      NT=8
      CALL REAERC
      CALL DOS
      CALL SOVMAT
  813 CONTINUE
  707 NT=3
      DO 781 NC=1,NCS
      CALL CONSVT
      CALL SOVMAT
      NT=NT+1
      DO 814 I=1,NCELLS
      CONS(I,NC)=Z(I)
  814 CONTINUE
  781 CONTINUE
  799 CONTINUE
      IF (TPRINT.LT.PTIME) GO TO 997
      TPRINT=0.0
  997 CONTINUE
```

```
C                                       STEP 7-3
C                                       IF STEADY-STATE CONDITION HAS NOT BEEN
C                                       REACHED, CONTINUE ROUTING.
C
C
C
      IF (TIME.LT.TMAX) GO TO 999
C
C                                       STEP 8-0
C                                       IF FLOW AUGMENTATION IS DESIRED, FIND
C                                       HOW MUCH IS REQUIRED, AUGMENT THE
C                                       NECESSARY HEADWATER FLOWS AND START
C                                       ROUTING AGAIN AT TIME = ZERO.
C
C
C
      IF (IAUGOP.EQ.0) GO TO 9999
      CALL FLOAUG
      IF (TIME.EQ.0.0) GO TO 998
 9999 CONTINUE
      CALL WRPT1
      STOP
      END
```

SUBROUTINE TRIMAT

```
      SUBROUTINE TRIMAT
C
C                                     TRIMAT COMPUTES THE COEFFICIENT MATRIX
C                                     FOR THE IMPLICIT-FINITE-DIFFERENCE FORM
C                                     OF THE ONE-DIMENSIONAL (ADVECTION +
C                                     DISPERSION) TRANSPORT EQUATION.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
C
C                                     STEP 1-0
C                                     INITIALIZE COUNTERS FOR HEADWATERS,
C                                     WASTE LOADS OR WITHDRAWLS, AND STREAM
C                                     JUNCTIONS.
C
      NHW=0
      NWS=0
      IJUNC=0
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     WITH NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IFL=IFLAG(I,J)
      GO TO (101,102,102,103,104,102,102), IFL
C
C                                     STEP 2-1
C                                     COMPUTE COEFFICIENTS B AND C FOR AN
C                                     ELEMENT OF TYPE 1.
C
  101 NHW=NHW+1
      A(IOR)=-DTODX2*DLHW(NHW)-HWFLOW(NHW)*DTOVCL(IOR)
      B(IOR)=1.0+DTODX2*(DLHW(NHW)+DL(IOR))+FLOW(IOR)*DTOVCL(IOR)
      C(IOR)=-DTODX2*DL(IOR)
      GO TO 100
C
C                                     STEP 2-2
C                                     COMPUTE COEFFICIENTS A,B, AND C FOR
C                                     ELEMENTS OF TYPE 2,3,6, OR 7.
C
  102 A(IOR)=-DTODX2*DL(IOR-1)-FLOW(IOR-1)*DTOVCL(IOR)
      B(IOR)=1.0+DTODX2*(DL(IOR-1)+DL(IOR))+FLOW(IOR)*DTOVCL(IOR)
      C(IOR)=-DTODX2*DL(IOR)
      GO TO 100
C
C                                     STEP 2-3
C                                     COMPUTE COEFFICIENTS A,B,C, AND D FOR AN
C                                     ELEMENT OF TYPE 4.
C
  103 IJUNC=IJUNC+1
      NS=1
      NN=JUNC(IJUNC,NS)
      D(IJUNC)=-DTODX2*DL(NN)-FLOW(NN)*DTOVCL(IOR)
      A(IOR)=-DTODX2*DL(IOR-1)-FLOW(IOR-1)*DTOVCL(IOR)
      B(IOR)=1.0+DTODX2*(DL(IOR-1)+DL(NN)+2.0*DL(IOR))+FLOW(IOR)*
     *       DTOVCL(IOR)
      C(IOR)=-DTODX2*DL(IOR)
      GO TO 100
C
C                                     STEP 2-4
C                                     COMPUTE COEFFICIENTS A AND B FOR AN
C                                     ELEMENT OF TYPE 5.
C
C
  104 A(IOR)=-DTODX2*(DL(IOR-1)+DL(IOR))-FLOW(IOR-1)*DTOVCL(IOR)
      B(IOR)=1.0+DTODX2*(DL(IOR-1)+DL(IOR))+FLOW(IOR)*DTOVCL(IOR)
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE SOVMAT

```
      SUBROUTINE SOVMAT
C
C                                   SOVMAT SOLVES A SYSTEM OF SIMULTANEOUS
C                                   LINEAR EQUATIONS WHOSE COEFFICIENT
C                                   MATRIX IS OF TRIDIAGONAL FORM USING
C                                   A MODIFIED GAUSSIAN ELIMINATION TYPE OF
C                                   ALGORITHM.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPOK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      DIMENSION IFLG(500)
C
C                                   STEP 1-0
C                                   INITIALIZE COUNTER FOR STREAM JUNCTIONS.
C
      IJUNC=0
C
C                                   STEP 2-0
C                                   LOOP THROUGH SYSTEM OF NREACH REACHES
C                                   WITH NCELR COMPUTATIONAL ELEMENTS PER
C                                   REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IFL=IFLAG(I,J)
      IFLG(IOR)=IFL
      GO TO (101,102,102,103,102,102,102), IFL
C
C                                   STEP 2-1
C                                   OPERATE ON EQUATION FOR AN ELEMENT OF
C                                   TYPE 1.
C
  101 W(IOR)=C(IOR)/B(IOR)
      G(IOR)=S(IOR)/B(IOR)
      GO TO 100
C
C                                   STEP 2-2
C                                   OPERATE ON EQUATION FOR ELEMENTS OF TYPE
C                                   2,3,5,6, OR 7.
C
  102 DENOM=B(IOR)-A(IOR)*W(IOR-1)
      W(IOR)=C(IOR)/DENOM
      G(IOR)=(S(IOR)-A(IOR)*G(IOR-1))/DENOM
      GO TO 100
C
C                                   STEP 2-3
C                                   OPERATE ON EQUATION FOR AN ELEMENT OF
C                                   TYPE 4.
C
  103 IJUNC=IJUNC+1
      NS=1
      NN=JUNC(IJUNC,NS)
      S(IOR)=S(IOR)-D(IJUNC)*G(NN)
      DENOM=B(IOR)-A(IOR)*W(IOR-1)
      W(IOR)=(C(IOR)-D(IJUNC)*W(NN))/DENOM
      G(IOR)=(S(IOR)-A(IOR)*G(IOR-1))/DENOM
  100 CONTINUE
C
C                                   STEP 3-0
C                                   SOLVE SYSTEM OF NREACH BY NCELR
C                                   EQUATIONS USING BACK SUBSTITUTION.
C
      Z(IOR)=G(IOR)
  109 IOR=IOR-1
      IFL=IFLG(IOR)
      GO TO (106,106,107,106,106,106,106), IFL
C
C                                   STEP 3-1
C                                   SOLVE THE EQUATION FOR ELEMENTS OF TYPE
C                                   1,2,4,5,6, OR 7.
C
  106 Z(IOR)=G(IOR)-W(IOR)*Z(IOR+1)
      IF (Z(IOR).LT.0.0) Z(IOR)=0.0
      GO TO 108
C
C                                   STEP 3-2
C                                   SOLVE THE EQUATION FOR AN ELEMENT OF
C                                   TYPE 3.
C
  107 NS=2
      NN=JUNC(IJUNC,NS)
      Z(IOR)=G(IOR)-W(IOR)*Z(NN)
      IF (Z(IOR).LT.0.0) Z(IOR)=0.0
      IJUNC=IJUNC-1
  108 CONTINUE
      IF (IOR.NE.1) GO TO 109
C
C                                   STEP 4-0
C                                   IF DESIRED, WRITE REPORT2 WHICH GIVES
C                                   AN INTERMEDIATE SUMMARY OF CONDITIONS
C                                   WITHIN THE SYSTEM AT ANY GIVEN TIME.
C
      IF (TPRINT.LT.PTIME) GO TO 99
      CALL WRPT2
   99 CONTINUE
      RETURN
      END
```

SUBROUTINE HYDRAU

```
      SUBROUTINE HYDRAU
C
C                                     HYDRAU PERFORMS A HYDROLOGIC BALANCE ON
C                                     THE SYSTEM BASED ON CONTINUITY. IT
C                                     COMPUTES THE FLOW, VELOCITY, VOLUME,
C                                     DEPTH, AND DISPERSION COEFFICIENT FOR
C                                     EVERY ELEMENT IN THE SYSTEM.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),EODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
C
C                                     STEP 1-0
C                                     INITIALIZE COUNTERS FOR HEADWATERS,
C                                     WASTE INPUTS OR WITHDRAWLS, AND STREAM
C                                     JUNCTIONS.
C
      NHW=0
      NWS=0
      IJUNC=0
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      CNCELR=NCELR
      QR=QI(I)/CNCELR
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IFL=IFLAG(I,J)
      GO TO (101,102,102,103,102,104,104), IFL
C
C                                     STEP 2-1
C                                     COMPUTE HYDRAULICS FOR AN ELEMENT OF
C                                     TYPE 1.
C
  101 NHW=NHW+1
      FLOW(IOR)=HWFLOW(NHW)+QR
      VHW(NHW)=COEFQV(I)*HWFLOW(NHW)**EXPOQV(I)
      DFPHW(NHW)=COEFQH(I)*HWFLOW(NHW)**EXPOQH(I)
      DLHW(NHW)=22.6*CMANN(I)*VHW(NHW)*DEPHW(NHW)**0.833
      VEL(IOR)=COEFQV(I)*FLOW(IOR)**EXPOQV(I)
      DTOVCL(IOR)=DT2ODX/(HWFLOW(NHW)/VHW(NHW)+FLOW(IOR)/VEL(IOR))
      GO TO 105
C
C                                     STEP 2-2
C                                     COMPUTE HYDRAULICS FOR ELEMENTS OF TYPE
C                                     2,3, OR 5.
C
  102 FLOW(IOR)=FLOW(IOR-1)+QR
      VEL(IOR)=COEFQV(I)*FLOW(IOR)**EXPOQV(I)
      DTOVCL(IOR)=DT2ODX/(FLOW(IOR-1)/VEL(IOR-1)+FLOW(IOR)/VEL(IOR))
      GO TO 105
C
C                                     STEP 2-3
C                                     COMPUTE HYDRAULICS FOR AN ELEMENT OF
C                                     TYPE 4.
C
  103 IJUNC=IJUNC+1
      NS=1
      NN=JUNC(IJUNC,NS)
      FLOW(IOR)=FLOW(IOR-1)+FLOW(NN)+QR
      VEL(IOR)=COEFQV(I)*FLOW(IOR)**EXPOQV(I)
      DTOVCL(IOR)=DT2ODX/(FLOW(IOR-1)/VEL(IOR-1)+FLOW(IOR)/VEL(IOR)+
     *            FLOW(NN)/VEL(NN))
      GO TO 105
C
C                                     STEP 2-4
C                                     COMPUTE HYDRAULICS FOR ELEMENTS OF TYPE
C                                     6 OR 7.
C
  104 NWS=NWS+1
      FLOW(IOR)=FLOW(IOR-1)+WSFLOW(NWS)+QR
      VEL(IOR)=COEFQV(I)*FLOW(IOR)**EXPOQV(I)
      DTOVCL(IOR)=DT2ODX/(FLOW(IOR-1)/VEL(IOR-1)+FLOW(IOR)/VEL(IOR))
  105 DFPTH(IOR)=COEFQH(I)*FLOW(IOR)**EXPOQH(I)
      DL(IOR)=22.6*CMANN(I)*VEL(IOR)*DEPTH(IOR)**0.833
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE REAERC
C
C                                     REAERC CAN EITHER READ IN REAERATION
C                                     COEFFICIENTS (OPTION 1), COMPUTE THEM
C                                     USING A SELECTED EQUATION (OPTIONS 2,3,
C                                     4,5, AND 6), OR COMPUTE THEM BASED ON
C                                     K2=A*Q**B. ALL K2'S  ARE TO THE BASE E.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,RE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      REAL K2
C
C                                     STEP 1-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      KOPT=K2OPT(I)
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IFL=IFLAG(I,J)
C
C                                     STEP 1-1
C                                     SELECT K2'S FOR ANY OPTION AS DESIRED
C                                     BY REACH.
C
C                                     KOPT = 1  K2 IS READ IN.
C                                     KOPT = 2  CHURCHILL (1962)
C                                     KOPT = 3  O'CONNER - DOBBINS (1956)
C                                     KOPT = 4  OWENS, EDWARDS, - GIBBS (1964)
C                                     KOPT = 5  THACKSTON - KRENKEL (1966)
C                                     KOPT = 6  LANGBIEN - DURUM (1967)
C                                     KOPT = 7  K2 = A * Q ** B
C
      GO TO (101,102,103,104,105,106,107), KOPT
  101 K2(IOR)=CK2(I)
      GO TO 100
  102 K2(IOR)=5.026*VEL(IOR)/DEPTH(IOR)**1.673*2.31
      GO TO 100
  103 DM=2.25E-08
      K2(IOR)=SQRT(DM*VEL(IOR))/DEPTH(IOR)**1.5*8.64E+04
      GO TO 100
  104 K2(IOR)=9.4*VEL(IOR)**0.67/DEPTH(IOR)**1.85*2.31
      GO TO 100
  105 F=0.176*VEL(IOR)/SQRT(DEPTH(IOR))
      SHRVEL=5.675*VEL(IOR)*CMANN(I)/(1.49*DEPTH(IOR)**1.167)
      K2(IOR)=10.8*(1.0+SQRT(F))*SHRVEL*2.31
      GO TO 100
  106 K2(IOR)=3.3*SQRT(VEL(IOR))/DEPTH(IOR)**1.333*2.31
      GO TO 100
  107 K2(IOR)=COEQK2(I)*FLOW(IOR)**EXPQK2(I)
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE HEATEX

```
      SUBROUTINE HEATEX
C
C                                     HEATEX COMPUTES THE NET AMOUNT OF HEAT
C                                     RADIATION FLUX BEING TRANSFERRED ACROSS
C                                     THE AIR-WATER INTERFACE BASED ON AN
C                                     ENERGY BUDGET WHICH CONSIDERS SOLAR
C                                     RADIATION, ATMOSPHERIC RADIATION, BACK
C                                     RADIATION, CONDUCTION, AND EVAPORATION.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),QTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,DILT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      REAL LLM,LSM,LAT
C
C                                     STEP 1-0
C                                     COMPUTE REQUIRED CONSTANTS
C
      PI=3.141628
      CON1=2.0*PI/365.0
      CON2=PI/180.0*LAT
      CON3=180.0/PI
      CON4=23.45*PI/180.0
      CON5=PI/12.0
      CON6=12.0/PI
      DELTSL=(LLM-LSM)/15.0
      SOLCON=438.0
      ELEXP=EXP(-ELEV/2532.0)
C
C                                     STEP 2-0
C                                     COMPUTE ALL TERMS REQUIRED FOR
C                                     EVALUATING THE VARIOUS FLUXES IN THE
C                                     ENERGY BUDGET
C
      IF (TOFDAY.NE.0.0) GO TO 77
C
C                                     STEP 2-1
C                                     COMPUTE SEASONAL AND DAILY POSITIONS OF
C                                     SUN RELATIVE TO A SELECTED LOCATION ON
C                                     THE EARTH'S SURFACE.
C
      REARTH=1.0+0.017*COS(CON1*(186.0-DAYOFY))
      DECLIN=CON4*COS(CON1*(172.0-DAYOFY))
      RR=REARTH**2
      EQTIME=0.000121-0.12319*SIN(CON1*(DAYOFY-1.0)-0.07014)
     *       -0.16549*SIN(2.0*CON1*(DAYOFY-1.0)+0.3088)
      DECLON=ABS(DECLIN)
      ACS=TAN(CON2)*TAN(DECLON)
      IF (ACS.EQ.0.0) GO TO 8
      X=SQRT(1.0-ACS*ACS)
      X=X/ACS
      ACS=ATAN(X)
      IF (DECLIN.GT.0.0) ACS=PI-ACS
      GO TO 9
    8 ACS=PI/2.0
    9 CONTINUE
C
C                                     STEP 2-2
C                                     COMPUTE STANDARD TIMES AT WHICH SUN
C                                     RISES AND SETS.
C
      STR=12.0-CON6*ACS+DELTSL
      STS=24.0-STR+2.0*DELTSL
      STR=0.0
      STE=STR+D2LT
      GO TO 78
   77 STR=STR+D2LT
      STE=STE+D2LT
   78 CONTINUE
C
C                                     STEP 2-3
C                                     READ IN LOCAL CLIMATALOGICAL DATA
C                                     AT DESIRED TIME INTERVAL (MINIMUM TIME
C                                     INTERVAL IS THREE HOURS).
C
      IF (TRLCD.NE.0.0) GO TO 82
      READ 12, CLOUD,DRYBLB,WETBLB,ATMPR,WIND
   12 FORMAT (30X,5F10.0)
      WIND=WIND*1.151
C
C                                     STEP 2-4
C                                     COMPUTE VAPOR PRESSURES, DEW POINT, AND
C                                     DAMPENING EFFECT OF CLOUDINESS.
C
      VPWR=0.1001*EXP(0.03*WETBLB)-0.0837
      VPAIR=VPWR-0.000367*ATMPR*(DRYBLB-WETBLB)
     *      *(1.0+(WETBLB-32.0)/1571.0)
      DEWPT=ALOG((VPAIR+0.0837)/0.1001)/0.03
      CS=1.0-0.65*CLOUD**2
      IF (CLOUD.GT.0.9) CS=0.50
      CNL=CLOUD*10.0+1.0
      NL=CNL
   82 CONTINUE
      TRLCD=TRLCD+D2LT
      IF (TRLCD.LT.2.9) GO TO 84
      TRLCD=0.0
   84 CONTINUE
      IF (STS.LE.STR.OR.STR.GE.STE) GO TO 35
      IF(STR.GT.STR.AND.STR.LT.STE) GO TO 41
      IF (STS.LT.STE.AND.STS.GT.STR) GO TO 42
```

```
C                                       STEP 2-5
C                                       COMPUTE HOUR ANGLES
C
C
      TR=STR-12.0-DELTSL+EQTIME
      TF=STE-12.0-DELTSL+EQTIME
      GO TO 43
   41 TR=STR-12.0-DELTSL+EQTIME
      TF=STE-12.0-DELTSL+EQTIME
      GO TO 43
   42 TR=STB-12.0-DELTSL+EQTIME
      TF=STS-12.0-DELTSL+EQTIME
   43 CONTINUE
      TALT=(TB+TE)/2.0
C
C                                       STEP 2-6
C                                       COMPUTE AMT OF CLEAR SKY, SOLAR
C                                       RADIATION, AND ALTITUDE OF SUN.
C
C
      SOLAR=SOLCON/RR*(SIN(CON2)*SIN(DECLIN)*(TE-TB)+CON6*COS(CON2)*
     *      COS(DECLIN)*(SIN(CON5*TE)-SIN(CON5*TB)))
      ALPHA=SIN(CON2)*SIN(DECLIN)+COS(CON2)*COS(DECLIN)*COS(CON5*TALT)
      IF (ABS(ALPHA).EQ.1.0) GO TO 4
      Y=SQRT(1.0-ALPHA*ALPHA)
      Y=ALPHA/Y
      ALPHA=ATAN(Y)
      GO TO 5
    4 IF (ALPHA.EQ.-1.0) GO TO 6
      ALPHA=PI/2.0
      GO TO 5
    6 ALPHA=-PI/2.0
    5 CONTINUE
      IF (ALPHA.LT.0.01) GO TO 35
C
C                                       STEP 2-7
C                                       COMPUTE ABSORPTION AND SCATTERING
C                                       DUE TO ATMOSPHERIC CONDITIONS.
C
C
      PWC=0.00614*EXP(0.0489*DEWPT)
      OAM=ELEXP/(SIN(ALPHA)+0.15*(ALPHA*CON3+3.885)**(-1.253))
      A1=EXP(-(0.465+0.0408*PWC)*(0.129+0.171*EXP(-0.880*OAM))*OAM)
      A2=EXP(-(0.465+0.0408*PWC)*(0.179+0.171*EXP(-0.721*OAM))*OAM)
C
C                                       STEP 2-8
C                                       COMPUTE REFLECTIVITY COEFFICIENTS.
C
C
      GO TO (30,31,31,31,31,31,32,32,32,32,33), NL
   30 AR=1.18
      BR=-0.77
      GO TO 34
   31 AR=2.20
      BR=-0.97
      GO TO 34
   32 AR=0.95
      BR=-0.75
      GO TO 34
   33 AR=0.35
      BR=-0.45
   34 CONTINUE
      RS=AR*(CON3*ALPHA)**BR
      ATC=(A2+0.5*(1.0-A1-DAT))/(1.0-0.5*RS*(1.0-A1+DAT))
C
C                                       STEP 2-9
C                                       COMPUTE NET SOLAR RADIATION AFTER
C                                       SCATTERING, ABSORPTION, AND REFLECTION.
C
C
      SONET=SOLAR*ATC*CS*(1.0-RS)
      GO TO 36
   35 SONET=0.0
   36 CONTINUE
      CLC=1.0+0.17*CLOUD**2
C
C                                       STEP 3-0
C                                       COMPUTE OTHER HEAT FLUXES AND PERFORM
C                                       ENERGY BUDGET FOR EACH COMPUTATIONAL
C                                       ELEMENT.
C
C
      HA=0.97*1.73E-09*2.89E-06*(DRYBLB+460.0)**6*CLC*D2LT
      DO 70 I=1,NREACH
      NCELR=NCELRH(I)
      DO 70 J=1,NCELR
      IOR=ICLORD(I,J)
      VPW=0.1001*EXP(0.03*T(IOR))-0.0837
      HR=0.97*1.73E-09*(T(IOR)+460.0)**4*D2LT
      EVAP=62.4*(AE+BE*WIND)
      HE=EVAP*(VPW-VPAIR)*(1084.0-0.5*T(IOR))*D2LT
      HC=0.01*EVAP*(DRYBLB-T(IOR))*(1084.0-0.5*T(IOR))*D2LT
      HV=EVAP*T(IOR)*D2LT
      HSNET(IOR)=SONET+HA-HR+HC-HE-HV
   70 CONTINUE
      TOFDAY=TOFDAY+D2LT
      IF (TOFDAY.LT.23.9) GO TO 85
      TOFDAY=0.0
      DAYOFY=DAYOFY+1.0
   85 CONTINUE
      RETURN
      END
```

SUBROUTINE TEMPS

```
      SUBROUTINE TEMPS
C
CCC                                   TEMPS PERFORMS A HEAT BALANCE FOR EACH
CCC                                   COMPUTATIONAL ELEMENT IN THE SYSTEM

      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K20PT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
C
CCC                                   STEP 1-0
CCC                                   INITIALIZE COUNTERS FOR HEADWATERS,
CCC                                   WASTE INPUTS OR WITHDRAWLS, AND STREAM
C                                     JUNCTIONS.

      NHW=0
      NWS=0
      IJUNC=0
      RHOCP=62.4
      CALL HEATEX
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      CNCELR=NCELR
      TPIJ=QI(I)/CNCELR*TI(I)
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH.
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IFL=IFLAG(I,J)
      GO TO (101,102,102,104,102,103,105), IFL
C
C                                     STEP 2-1
C                                     PERFORM HEAT BALANCE ON ELEMENTS OF TYPE
C                                     1.
C
  101 NHW=NHW+1
      ADEPTH=0.5*(DEPHW(NHW)+DEPTH(IOR))
      REACT=HSNET(IOR)/(RHOCP*ADEPTH)
      S(IOR)=T(IOR)+REACT+TPIJ*DTOVCL(IOR)-A(IOR)*HWTEMP(NHW)
      GO TO 100
C
C                                     STEP 2-2
C                                     PERFORM HEAT BALANCE ON ELEMENTS OF TYPE
C                                     2,3, OR 5.
C
  102 ADEPTH=0.5*(DEPTH(IOR-1)+DEPTH(IOR))
      REACT=HSNET(IOR)/(RHOCP*ADEPTH)
      S(IOR)=T(IOR)+REACT+TPIJ*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-3
C                                     PERFORM HEAT BALANCE ON ELEMENTS OF TYPE
C                                     6.
C
  103 NWS=NWS+1
      ADEPTH=0.5*(DEPTH(IOR-1)+DEPTH(IOR))
      REACT=HSNET(IOR)/(RHOCP*ADEPTH)
      S(IOR)=T(IOR)+REACT+(TPIJ+WSFLOW(NWS)*WSTEMP(NWS))*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-4
C                                     PERFORM HEAT BALANCE ON ELEMENTS OF TYPE
C                                     4.
C
  104 IJUNC=IJUNC+1
      NS=1
      NN=JUNC(IJUNC,NS)
      ADEPTH=0.25*(DEPTH(IOR-1)+DEPTH(NN)+2.0*DEPTH(IOR))
      REACT=HSNET(IOR)/(RHOCP*ADEPTH)
      S(IOR)=T(IOR)+REACT+TPIJ*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-5
C                                     PERFORM HEAT BALANCE ON ELEMENTS OF TYPE
C                                     7.
C
  105 NWS=NWS+1
      ADEPTH=0.5*(DEPTH(IOR-1)+DEPTH(IOR))
      REACT=HSNET(IOR)/(RHOCP*ADEPTH)
      S(IOR)=T(IOR)+REACT+(TPIJ+WSFLOW(NWS)*T(IOR))*DTOVCL(IOR)
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE BODS

```
      SUBROUTINE BODS
C
C                                     BODS PERFORMS A BIOCHEMICAL OXYGEN
C                                     DEMAND BALANCE FOR EACH COMPUTATIONAL
C                                     ELEMENT IN THE SYSTEM.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      REAL K1,K3
C
C                                     STEP 1-0
C                                     INITIALIZE COUNTERS ON HEADWATERS AND
C                                     WASTE INPUTS OR WITHDRAWLS.
C
      NHW=0
      NWS=0
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATION ELEMENTS PER
C                                     REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      CNCELR=NCELR
      BODIJ=QI(I)/CNCELR*BODI(I)
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      TC=0.556*(T(IOR)-68.0)
      K1(IOR)=CK1(I)*1.047**TC
      K3=CK3(I)
      REACT=-D1LT*(K1(IOR)+K3)*BOD(IOR)
      IFL=IFLAG(I,J)
      GO TO (101,102,102,102,102,103,104), IFL
C
C                                     STEP 2-1
C                                     PERFORM BOD BALANCE FOR ELEMENTS OF TYPE
C                                     1.
C
  101 NHW=NHW+1
      S(IOR)=BOD(IOR)+REACT+BODIJ*DTOVCL(IOR)-A(IOR)*HWBOD(NHW)
      GO TO 100
C
C                                     STEP 2-2
C                                     PERFORM BOD BALANCE FOR ELEMENTS OF TYPE
C                                     2,3,4,OR 5.
C
  102 S(IOR)=BOD(IOR)+REACT+BODIJ*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-3
C                                     PERFORM BOD BALANCE FOR ELEMENTS OF TYPE
C                                     6.
C
  103 NWS=NWS+1
      S(IOR)=BOD(IOR)+REACT+(BODIJ+WSFLOW(NWS)*WSBOD(NWS))*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-4
C                                     PERFORM BOD BALANCE FOR ELEMENTS OF TYPE
C                                     7.
C
  104 NWS=NWS+1
      S(IOR)=BOD(IOR)+REACT+(BODIJ+WSFLOW(NWS)*BOD(IOR))*DTOVCL(IOR)
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE DOS

```
      SUBROUTINE DOS
C
C                                     DOS PERFORMS A DISSOLVED OXYGEN BALANCE
C                                     FOR EACH COMPUTATIONAL ELEMENT IN THE
C                                     SYSTEM.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      REAL K1,K2,KO
C
C                                     STEP 1-0
C                                     INITIALIZE COUNTERS ON HEADWATERS,
C                                     WASTE INPUTS OR WITHDRAWLS, AND STREAM
C                                     JUNCTIONS.
C
      NHW=0
      NWS=0
      IJUNC=0
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      CNCELR=NCELR
      DOIJ=QI(I)/CNCELR*DOI(I)
      RATIO=1.0/(1.0-EXP(-5.0*CK1(I)))
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      TC=0.556*(T(IOR)-68.0)
      K1(IOR)=K1(IOR)*RATIO
      DOSAT=14.89-0.4259*T(IOR)+0.003734*T(IOR)**2-0.00001328*T(IOR)**3
      IFL=IFLAG(I,J)
      GO TO (101,102,102,104,102,103,105), IFL
C
C                                     STEP 2-1
C                                     PERFORM D.O. BALANCE FOR ELEMENTS OF
C                                     TYPE 1.
C
  101 NHW=NHW+1
      KO=K2(IOR)*1.0159**TC
      REACT=D1LT*(KO*(DOSAT-DO(IOR))-K1(IOR)*BOD(IOR))
      S(IOR)=DO(IOR)+REACT+DOIJ*DTOVCL(IOR)-A(IOR)*HWDO(NHW)
      GO TO 100
C
C                                     STEP 2-2
C                                     PERFORM D.O. BALANCE FOR ELEMENTS OF
C                                     TYPE 2,3,OR 5.
C
  102 KO=(0.5*(K2(IOR-1)+K2(IOR)))*1.0159**TC
      REACT=D1LT*(KO*(DOSAT-DO(IOR))-K1(IOR)*BOD(IOR))
      S(IOR)=DO(IOR)+REACT+DOIJ*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-3
C                                     PERFORM D.O. BALANCE FOR ELEMENTS OF
C                                     TYPE 6.
C
  103 NWS=NWS+1
      KO=(0.5*(K2(IOR-1)+K2(IOR)))*1.0159**TC
      REACT=D1LT*(KO*(DOSAT-DO(IOR))-K1(IOR)*BOD(IOR))
      S(IOR)=DO(IOR)+REACT+(DOIJ+WSFLOW(NWS)*WSDO(NWS))*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-4
C                                     PERFORM D.O. BALANCE FOR ELEMENTS OF
C                                     TYPE 4.
C
  104 IJUNC=IJUNC+1
      NS=1
      NN=JUNC(IJUNC,NS)
      KO=(0.25*(K2(IOR-1)+K2(NN)+2.0*K2(IOR)))*1.0159**TC
      REACT=D1LT*(KO*(DOSAT-DO(IOR))-K1(IOR)*BOD(IOR))
      S(IOR)=DO(IOR)+REACT+DOIJ*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-5
C                                     PERFORM D.O. BALANCE FOR ELEMENTS OF
C                                     TYPE 7.
C
  105 NWS=NWS+1
      KO=(0.5*(K2(IOR-1)+K2(IOR)))*1.0159**TC
      REACT=D1LT*(KO*(DOSAT-DO(IOR))-K1(IOR)*BOD(IOR))
      S(IOR)=DO(IOR)+REACT+(DOIJ+WSFLOW(NWS)*DO(IOR))*DTOVCL(IOR)
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE CONSVT

```
      SUBROUTINE CONSVT
C
C                                     CONSVT PERFORMS A CONSERVATIVE MINERAL
C                                     BALANCE FOR EACH COMPUTATIONAL ELEMENT
C                                     IN THE SYSTEM.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CHANN(25),CK1(25),CK3(25),K20PT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),YI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),R2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,DILT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
C
C                                     STEP 1-0
C                                     INITIALIZE COUNTERS ON HEADWATERS AND
C                                     WASTE INPUTS OR WITHDRAWLS.
C
      NHW=0
      NWS=0
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      CNCELR=NCELR
      CONSIJ=QI(I)/CNCELR*CONSI(I,NC)
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IFL=IFLAG(I,J)
      GO TO (101,102,102,102,102,103,104), IFL
C
C                                     STEP 2-1
C                                     PERFORM CONSERVATIVE MINERAL BALANCE
C                                     FOR ELEMENTS OF TYPE 1.
C
  101 NHW=NHW+1
      S(IOR)=CONS(IOR,NC)+CONSIJ*DTOVCL(IOR)-A(IOR)*HWCONS(NHW,NC)
      GO TO 100
C
C                                     STEP 2-2
C                                     PERFORM CONSERVATIVE MINERAL BALANCE
C                                     FOR ELEMENTS OF TYPE 2,3,4,OR 5.
C
  102 S(IOR)=CONS(IOR,NC)+CONSIJ*DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-3
C                                     PERFORM CONSERVATIVE MINERAL BALANCE
C                                     FOR ELEMENTS OF TYPE 6.
C
  103 NWS=NWS+1
      S(IOR)=CONS(IOR,NC)+(CONSIJ+WSFLOW(NWS)*WSCONS(NWS,NC))*
     *       DTOVCL(IOR)
      GO TO 100
C
C                                     STEP 2-4
C                                     PERFORM CONSERVATIVE MINERAL BALANCE
C                                     FOR ELEMENTS OF TYPE 7.
C
  104 NWS=NWS+1
      S(IOR)=CONS(IOR,NC)+(CONSIJ+WSFLOW(NWS)*CONS(IOR,NC))*DTOVCL(IOR)
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE FLOAUG

```
      SUBROUTINE FLOAUG
C
C                                     FLOAUG SEARCHES THROUGH THE SYSTEM BY
C                                     REACH TO DETERMINE THE MINIMUM DO LEVEL
C                                     WITHIN EACH REACH. EACH OF THESE MINIMUM
C                                     DO LEVELS IS CHECKED AGAINST A SELECTED
C                                     TARGET LEVEL. IF FLOW AUGMENTATION IS
C                                     REQUIRED , THIS FLOW IS DISTRIBUTED
C                                     EQUALLY AMONG THE HEADWATER SOURCES THAT
C                                     ARE AVAILABLE TO A GIVEN REACH.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRM(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,DILT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      DIMENSION IORMIN(25),RMILE(25),DOMIN(25),IORDER(25),QAUG(10)
C
C                                     STEP 1-0
C                                     INITIALIZE AUMENTATION FLOWS
      DO 5 NHW=1,NHWTRS
      QAUG(NHW)=0.0
    5 CONTINUE
C
C                                     STEP 2-0
C                                     LOOP THROUGH SYSTEM OF NREACH REACHES
C                                     AND NCELR COMPUTATIONAL ELEMENTS PER
C                                     REACH TO DETERMINE MINIMUM DO LEVEL BY
C                                     REACH AND ITS LOCATION BY RIVER MILE.
C
      DO 50 I=1,NREACH
      DOMIN(I)=100.0
      IF(NHWWAR(I).EQ.0) GO TO 50
      NCELR=NCELRM(I)
      DO 100 J=1,NCELR
      IOR=ICLORD(I,J)
      IF (DO(IOR).GE.DOMIN(I)) GO TO 100
      DOMIN(I)=DO(IOR)
      IORMIN(I)=IOR
      XMIN=J
      RMILE(I)=RMTHOR(I)-XMIN*DELX/5280.0
  100 CONTINUE
   50 CONTINUE
      NBTARG=0
C
C                                     STEP 3-0
C                                     LOOP THROUGH NREACH REACHES TO SEE IF
C                                     MINIMUM DO LEVEL IS BELOW TARGET LEVEL.
C
      DO 25 I=1,NREACH
      IF (DOMIN(I).GE.TARGDO(I)) GO TO 25
C
C                                     STEP 3-1
C                                     IF TARGET LEVEL IS NOT MET, COMPUTE
C                                     AMOUNT OF FLOW AUGMENTATION REQUIRED.
C
      NBTARG=NBTARG+1
      IORDER(NBTARG)=I
      IOR=IORMIN(I)
      RMILE(NBTARG)=RMILE(I)
      DOREQD=TARGDO(I)-DOMIN(I)+0.1
      QREQD = FLOW(IOR)*(DOREQD/TARGDO(I) + 0.15*
     *(DOREQD/TARGDO(I))**2)
      QSUM=0.0
      NHWAR=NHWWAR(I)
      DO 350 J=1,NHWAR
      NHW=IAUGOR(I,J)
      QSUM=QSUM+QAUG(NHW)
  350 CONTINUE
C
C                                     STEP 3-2
C                                     DIVIDE TOTAL AUGMENTATION REQUIRED
C                                     EQUALLY AMONG THE UPSTREAM HEADWATER
C                                     SOURCES AVAILABLE TO A GIVEN REACH.
C
      QADD=QREQD/NHWWAR(I)
C
C                                     STEP 3-3
C                                     CHECK TO SEE THAT AN EXCESS OF FLOW
C                                     AUGMENTATION HAS NOT BEEN USED.
C
      IF (QREQD.LT.QSUM) GO TO 25
      NHWAR=NHWWAR(I)
      DO 375 J=1,NHWAR
      NHW=IAUGOR(I,J)
      QAUG(NHW)=QADD
  375 CONTINUE
   25 CONTINUE
      IF (NBTARG.EQ.0) GO TO 300
C
C                                     STEP 4-0
C                                     WRITE SUMMARY OF FLOW AUG#MT. REQ#D.
C
      WRITE (NJ,200)
  200 FORMAT (1H1,38X,39H* * * REACHES WITH OXYGEN DEFICIT * * *,//,23X,
     *        52HREACH NO.     REACH IDENTIFICATION       MINIMUM DO.,
     *        15H     RIVER MILE,/)
      TIMF=0.0
      DO 250 K=1,NBTARG
```

```
      I=IORDER(K)
      WRITE (NJ,255) I,(RCHID(I,J),J=1,5),DOMIN(I),RMILE(I)
  255 FORMAT (22X,I5,10X,5A4,7X,F5.1,11X,F6.1)
  250 CONTINUE
      WRITE (NJ,260)
  260 FORMAT (1H0,30X,33H* * * FLOW AUGMENTATION REQUIRED * * *.//.
     *       5X,10HHEADWATER NO.     HEADWATER IDENTIFICATION     EXIS
     *TING HEADWATER FLOW (CFS)     AUG. REQUIRED (CFS)./)
      DO 270 NHW=1,NHWTRS
      WRITE (NJ,275) NHW,(HWTRID(NHW,J),J=1,5),HWFLOW(NHW),QAUG(NHW)
  275 FORMAT (8X,I5,12X,5A4,16X,F10.1,20X,F10.1)
  270 CONTINUE
      DO 380 NHW=1,NHWTRS
      HWFLOI=QATOT(NHW)
      QATOT(NHW)=HWFLOW(NHW)-HWFLOI
      HWFLOW(NHW)=HWFLOI
  380 CONTINUE
      GO TO 310
  300 CONTINUE
C
C                                     STEP 5-0
C                                     WRITE FINAL SUMMARY OF FLOW
C                                     AUGMENTATION REQUIREMENTS.
C
      WRITE (NJ,261)
  261 FORMAT (1H0,33X,32HTOTAL FLOW AUGMENTATION REQUIRED.//.
     *5X,10HHEADWATER NO.     HEADWATER IDENTIFICATION     INITIAL  HE
     *ADWATER FLOW (CFS)     AUG. REQUIRED (CFS)./)
      DO 305 NHW=1,NHWTRS
      HWFLOW(NHW)=HWFLOW(NHW)-QATOT(NHW)
      WRITE (NJ,275) NHW,(HWTRID(NHW,J),J=1,5),HWFLOW(NHW),QATOT(NHW)
  305 CONTINUE
  310 CONTINUE
      RETURN
      END
```

SUBROUTINE WRPT1

```
      SUBROUTINE WRPT1
C
C                                  WRPT1 GIVES A FINAL SUMMARY (REACH BY
C                                  REACH) AFTER STEADY-STATE CONDITIONS
C                                  HAVE BEEN REACHED. IT SUMMARIZES THE
C                                  CONDITIONS AT THE BEGINNING AND END OF
C                                  EACH REACH AS WELL AS THE MAXIMUM,
C                                  MINIMUM, AND AVERAGE CONDITIONS WITHIN
C                                  THE REACH.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       GI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),S(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,DILT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYHLB,WETBLB,OEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      DIMENSION PNAME(5,13),CONMAX(3),CONMIN(3),CONAVE(3)
      REAL K2,K2MAX,K2MIN,K2AVE
      DATA PNAME   /4HRIVE,4HR MI,4HLE  ,4H    ,4H  = ,
     *              4HFLOW,4H (CF,4HS)  ,4H    ,4H  = ,
     *              4HVELO,4HCITY,4H (FP,4HS)  ,4H  = ,
     *              4HDEPT,4HH (F,4HT)  ,4H    ,4H  = ,
     *              4HK1 (,4H1/DA,4HY)  ,4H    ,4H  = ,
     *              4HK2 (,4H1/DA,4HY)  ,4H    ,4H  = ,
     *              4HK3 (,4H1/DA,4HY)  ,4H    ,4H  = ,
     *              4HTEMP,4H (F),4H    ,4H    ,4H  = ,
     *              4HBOD ,4H(MG/,4HL)  ,4H    ,4H  = ,
     *              4HDO (,4HMG/L,4H)   ,4H    ,4H  = ,
     *              4HCONS,4H ONE,4H (MG,4H/L) ,4H  = ,
     *              4HCONS,4H TWO,4H (MG,4H/L) ,4H  = ,
     *              4HCONS,4H THR,4HEE (,4HMG/L,4H) = /
C
C                                  STEP 1-0
C                                  LOOP THROUGH SYSTEM OF NREACH REACHES.
C
      DO 100 I=1,NREACH
C
C                                  STEP 1-1
C                                  INITIALIZE TERMS.
C
      FLOAVE=0.0
      FLOMAX=0.0
      FLOMIN=1.0E+06
      K2AVE =0.0
      K2MAX =0.0
      K2MIN =1.0E+06
      TEMAVE=0.0
      TEMMAX=0.0
      TEMMIN=1.0E+06
      BODAVE=0.0
      BODMAX=0.0
      BODMIN=1.0E+06
      DOAVE=0.0
      DOMAX=0.0
      DOMIN=1.0E+06
      DO 70 NC=1,NCS
      CONAVE(NC)=0.0
      CONMAX(NC)=0.0
      CONMIN(NC)=1.0E+06
   70 CONTINUE
      NCELR=NCELRH(I)
      AVE=NCELR
      IS=ICLORD(I,1)
      IF=IS-1+NCELR
C
C                                  STEP 1-2
C                                  LOOP THROUGH EACH REACH WITH NCELR
C                                  COMPUTATIONAL ELEMENTS PER REACH.
C
      DO 50 J=1,NCELR
      IOR=ICLORD(I,J)
C
C                                  STEP 1-3
C                                  FIND MAXIMUM, MINIMUM, AND AVERAGE
C                                  CONDITIONS WITHIN EACH REACH.
C
      IF (FLOW(IOR).LT.FLOMAX) GO TO 1
      FLOMAX=FLOW(IOR)
    1 IF (FLOW(IOR).GT.FLOMIN) GO TO 2
      FLOMIN=FLOW(IOR)
    2 FLOAVE=FLOAVE+FLOW(IOR)/AVE
      IF (K2(IOR).LT.K2MAX) GO TO 3
      K2MAX=K2(IOR)
    3 IF (K2(IOR).GT.K2MIN) GO TO 4
      K2MIN=K2(IOR)
    4 K2AVE=K2AVE+K2(IOR)/AVE
      IF (T(IOR).LT.TEMMAX) GO TO 5
      TEMMAX=T(IOR)
    5 IF (T(IOR).GT.TEMMIN) GO TO 6
      TEMMIN=T(IOR)
    6 TEMAVE=TEMAVE+T(IOR)/AVE
      IF (BOD(IOR).LT.BODMAX) GO TO 7
      BODMAX=BOD(IOR)
    7 IF (BOD(IOR).GT.BODMIN) GO TO 8
      BODMIN=BOD(IOR)
    8 BODAVE=BODAVE+BOD(IOR)/AVE
      IF (DO(IOR).LT.DOMAX) GO TO 9
      DOMAX=DO(IOR)
    9 IF (DO(IOR).GT.DOMIN) GO TO 10
      DOMIN=DO(IOR)
   10 DOAVE=DOAVE+DO(IOR)/AVE
      DO 15 NC=1,NCS
      IF (CONS(IOR,NC).LT.CONMAX(NC)) GO TO 11
      CONMAX(NC)=CONS(IOR,NC)
```

```
   11 IF (CONS(IOR,NC).GT.CONMIN(NC)) GO TO 12
      CONMIN(NC)=CONS(IOR,NC)
   12 CONAVE(NC)=CONAVE(NC)+CONS(IOR,NC)/AVE
   15 CONTINUE
   50 CONTINUE
      VELMAX=COEFQV(I)*FLOMAX**EXPOQV(I)
      VELMIN=COEFQV(I)*FLOMIN**EXPOQV(I)
      VELAVE=COEFQV(I)*FLOAVE**EXPOQV(I)
      DEPMAX=COEFQH(I)*FLOMAX**EXPOQH(I)
      DEPMIN=COEFQH(I)*FLOMIN**EXPOQH(I)
      DEPAVE=COEFQH(I)*FLOAVE**EXPOQH(I)
C
C                                        STEP 2-0
C                                        WRITE FINAL SUMMARY.
C
      WRITE (NJ,101) I,(RCHID(I,J),J=1,5)
  101 FORMAT (1H1,/////,42X,24H* * * FINAL REPORT * * *,//,
     *        36X,9HREACH NO.,I5,2H (,5A4,1H))
      WRITE (NJ,102)
  102 FORMAT (1H0,11X,9HPARAMETER,9X,13HHEAD OF REACH,7X,
     *        12HEND OF REACH,5X,7HMAXIMUM,5X,7HMINIMUM,5X,7HAVERAGE)
      WRITE (NJ,104) (PNAME(J,1),J=1,5),RMTHOR(I),RMTEOR(I)
  104 FORMAT (/,9X,5A4,F10.1,10X,F10.1)
  103 FORMAT (/,9X,5A4,F10.3,10X,F10.3,4X,F10.3,2(2X,F10.3))
      WRITE (NJ,103) (PNAME(J,2),J=1,5),FLOW(IS),FLOW(IE),FLOMAX,
     *               FLOMIN,FLOAVE
      WRITE (NJ,103) (PNAME(J,3),J=1,5),VEL(IS),VEL(IE),VELMAX,
     *               VELMIN,VELAVE
      WRITE (NJ,103) (PNAME(J,4),J=1,5),DEPTH(IS),DEPTH(IE),
     *               DEPMAX,DEPMIN,DEPAVE
      WRITE (NJ,103) (PNAME(J,5),J=1,5),CK1(I),CK1(I),CK1(I),
     *               CK1(I),CK1(I)
      WRITE (NJ,103) (PNAME(J,6),J=1,5),K2(IS),K2(IE),K2MAX,
     *               K2MIN,K2AVE
      WRITE (NJ,103) (PNAME(J,7),J=1,5),CK3(I),CK3(I),CK3(I),
     *               CK3(I),CK3(I)
      WRITE (NJ,103) (PNAME(J,8),J=1,5),T(IS),T(IE),TEMMAX,
     *               TEMMIN,TEMAVE
      WRITE (NJ,103) (PNAME(J,9),J=1,5),BOD(IS),BOD(IE),BODMAX,
     *               BODMIN,BODAVE
      WRITE (NJ,103) (PNAME(J,10),J=1,5),DO(IS),DO(IE),DOMAX,
     *               DOMIN,DOAVE
      DO 85 NC=1,NCS
      JN=NC+10
      WRITE (NJ,103) (PNAME(J,JN),J=1,5),CONS(IS,NC),CONS(IE,NC),
     *               CONMAX(NC),CONMIN(NC),CONAVE(NC)
   85 CONTINUE
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE WRPT2

```
      SUBROUTINE WRPT2
C
C                                        WRPT2 WRITES AN INTERMEDIATE SUMMARY
C                                        OF THE SELECTED QUALITY CONSTITUENT/S.
C                                        THESE CONSTITUENTS ARE WRITTEN BY REACH
C                                        AND BY ELEMENT. THIS SUMMARY CAN BE
C                                        GIVEN AT A TIME INTERVAL OF DELT OR
C                                        SOME MULTIPLE OF DELT.
C
      COMMON TITLE(20,20),RCHID(25,5),RMTHOR(25),RMTEOR(25),NHWWAR(25),
     *       TARGDO(25),IAUGOR(25,6),NCELRH(25),IFLAG(25,20),
     *       ICLORD(25,20),COEFQV(25),EXPOQV(25),COEFQH(25),EXPOQH(25),
     *       CMANN(25),CK1(25),CK3(25),K2OPT(25),CK2(25),COEQK2(25),
     *       EXPQK2(25),TINIT(25),DOINIT(25),BOINIT(25),COINIT(25,3),
     *       QI(25),TI(25),DOI(25),BODI(25),CONSI(25,3),JUNCID(5,5),
     *       JUNC(5,3),HWTRID(5,5),HWFLOW(5),HWTEMP(5),HWDO(5),
     *       HWBOD(5),HWCONS(5,3),WASTID(25,5),TRFACT(25),WSFLOW(25),
     *       WSTEMP(25),WSDO(25),WSBOD(25),WSCONS(25,3),QATOT(5),
     *       A(500),B(500),C(500),D(5),F(500),Z(500),W(500),G(500),
     *       FLOW(500),DEPTH(500),VEL(500),DTOVCL(500),K2(500),K1(500),
     *       HSNET(500),DL(500),VHW(5),DEPHW(5),DLHW(5),T(500),
     *       DO(500),BOD(500),CONS(500,3),PTIME,TPRINT,DELX,
     *       NHWTRS,NREACH,NWASTE,NJUNC,DELT,D1LT,D2LT,DTODX2,DT2ODX,
     *       LAT,LSM,LLM,ELEV,DAT,AE,BE,DAYOFY,DRYBLB,WETBLB,DEWPT,
     *       ATMPR,WIND,CLOUD,SONET,NI,NJ,TRLCD,TOFDAY,NT,NC,TIME,NCS
      DIMENSION P(20)
      TINDAY=TIME/24.0
      WRITE (NJ,50) (TITLE(NT,J),J=6,20),TINDAY
   50 FORMAT (1H0,19X,15A4,1X,F5.2,5H DAYS,/)
      WRITE (NJ,60)
   60 FORMAT (2X,103HRCH/CL 1    2    3    4    5    6    7    8    9
     *10   11   12   13   14   15   16   17   18   19   20,/)
C
C                                        STEP 1-0
C                                        LOOP THROUGH SYSTEM OF NREACH REACHES
C                                        BY NCELR COMPUTATIONAL ELEMENTS PER
C                                        REACH.
C
      DO 100 I=1,NREACH
      NCELR=NCELRH(I)
      DO 200 J=1,NCELR
      IOR=ICLORD(I,J)
      P(J)=Z(IOR)
      IF (NT.LE.5) P(J)=P(J)/10.0
  200 CONTINUE
C
C                                        STEP 1-1
C                                        WRITE INTERMEDIATE SUMMARY.
C
      WRITE (NJ,300) I,(P(J),J=1,NCELR)
  300 FORMAT (2X,I3,20F5.1)
  100 CONTINUE
      RETURN
      END
```

VI. QUAL-I PROGRAM VARIABLE DESCRIPTIONS

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QUAL-I

DESCRIPTION OF VARIABLES
IN COMMON

VARIABLE NAME	DEFINITION	UNITS
A(IOR)	= Vector below diagonal in tridiagonal coefficient matrix	-------
AE	= Evaporation coefficient	Ft/Hour-in. Hg
ATMPR	= Local barometric pressure	in. Hg
B(IOR)	= Diagonal vector in tridiagonal coefficient matrix	-------
BE	= Evaporation coefficient	Ft/Hour-in. Hg-MPH
BOD(IOR)	= 5-Day BOD in computational element	Mg/L
BODI(I)	= 5-Day BOD of incremental inflow	Mg/L
BOINIT(I)	= Initial 5-Day BOD	Mg/L
C(IOR)	= Vector above diagonal in tridiagonal coefficient matrix	-------
CK1(I)	= Deoxygenation coefficient (base e)	1/Day
CK2(I)	= Reaeration coefficient (base e)	1/Day
CK3(I)	= Rate of settling or scouring of BOD, Base (e)	1/Day
CLOUD	= Fraction of sky covered (cloudiness expressed as decimal)	-------
CMANN(I)	= Manning's channel roughness coefficient	-------
COEFQH(I)	= Coefficient of flow for depth-discharge relationship	-------
COEFQV(I)	= Coefficient of flow for velocity-discharge relationship	-------

VARIABLE NAME	DEFINITION	UNITS
COEQK2(I)	= Coefficient of flow for reaeration-discharge relationship	-------
COINIT(I,NC)	= Initial conservative mineral concentration	Mg/L
CONS(IOR,NC)	= Concentration of conservative minerals in computational element	Mg/L
CONSI(I,NC)	= Concentration of conservative minerals in incremental inflow	Mg/L
D(IJUNC)	= Vector of coefficients not in the tridiagonal portion of the coefficient matrix	-------
DAT	= Dust attenuation coefficient	-------
DAYOFY	= Day of the year on which temperature routing begins (from January 1)	Days
DELT	= Time interval of integration (time step over which the solution to the routing equation is advanced)	Seconds
DELX	= Space interval of integration (length of computational element)	Miles
DEPHW(NHW)	= Depth at headwater source	Feet
DEPTH(IOR)	= Depth in computational element	Feet
DEWPT	= Dew point temperature	Degrees Fahr.
DL(IOR)	= Dispersion coefficient in computational element	Ft^2/Sec
DLHW(NHW)	= Dispersion coefficient at headwater source	Ft^2/Sec
DO(IOR)	= Dissolved oxygen concentration in computational element	Mg/L
DOI(I)	= Dissolved oxygen concentration in incremental inflow	Mg/L
DOINIT(I)	= Initial dissolved oxygen concentration	Mg/L

VARIABLE NAME		DEFINITION	UNITS
DRYBLB	=	Dry bulb temperature	Degrees Fahr.
DTODX2	=	DELT/DELX^2	Sec/Ft^2
DT2ODX	=	(2.0 x DELT)/DELX	Sec/Ft
DTOVCL(IOR)	=	DT2ODX/(FLOW(IOR)/VEL(IOR) + FLOW(IOR-1)/VEL(IOR-1))	Sec/Ft^3
D1LT	=	Time interval of integration	Days
D2LT	=	Time interval of integration	Hours
ELEV	=	Mean elevation of river basin	Ft
EXPOQH(I)	=	Exponent of flow for depth-discharge relationship	-------
EXPOQV(I)	=	Exponent of flow for velocity-discharge relationship	-------
EXPQK2(I)	=	Exponent of flow for reaeration-discharge relationship	-------
FLOW(IOR)	=	Discharge in computational element	CFS
HSNET(IOR)	=	Net heat exchanged through air-water interface in computational element	BTU/Ft^2
HWBOD(NHW)	=	5-day BOD of headwater source	Mg/L
HWCONS(NHW,NC)	=	Concentration of conservative minerals at headwater source	Mg/L
HWDO(NHW)	=	Dissolved oxygen concentration at headwater source	Mg/L
HWFLOW(NHW)	=	Discharge at headwater source	CFS
HWTEMP(NHW)	=	Temperature at headwater source	Degrees Fahr.
HWTRID(NHW,5)	=	Alphanumeric name of headwater source	-------
IAUGOR(I,NHW)	=	Order of headwater sources available for flow augmentation	-------
ICLORD(I,J)	=	Order of computation	-------

VARIABLE NAME		DEFINITION	UNITS
IFLAG(I,J)	=	Computational flag field	-------
JUNC(IJUNC,3)	=	Order of computational elements clockwise around junction	-------
JUNCID(IJUNC,5)	=	Alphanumeric name of stream junction	-------
K1(IOR)	=	Deoxygenation coefficient in computational element (base e)	1/Day
K2(IOR)	=	Reaeration coefficient in computational element (base e)	1/Day
K2OPT(I)	=	Option for determining reaeration coefficients	-------
LAT	=	Mean latitude of river basin	Degrees
LLM	=	Local meridian of river basin	Degrees
LSM	=	Standard meridian of time zone in which river basin is located	Degrees
NC	=	Counter for the conservative mineral being routed	-------
NCELRH(I)	=	Number of computational elements in reach (maximum = 20)	-------
NCS	=	Number of conservative minerals being routed (maximum = 3)	-------
NHWTRS	=	Number of headwaters in stream system (maximum = 5)	-------
NHWWAR(I)	=	Number of headwater sources available for flow augmentation	-------
NI	=	Input tape	-------
NJ	=	Output tape	-------
NJUNC	=	Number of stream junctions in system (maximum = 5)	-------
NREACH	=	Number of reaches in system (maximum = 25)	-------
NT	=	Counter for printing titles	-------

VARIABLE NAME		DEFINITION	UNITS
NWASTE	=	Number of waste discharges or withdrawals (maximum = 25)	-------
PTIME	=	Time interval for writing intermediate summary	Hours
QATOT(NHW)	=	Total flow augmentation from each headwater source used	CFS
QI(I)	=	Incremental inflow	CFS
RCHID(I,5)	=	Alphanumeric name of reach	-------
RMTEOR(I)	=	River mile at end of reach	Miles
RMTHOR(I)	=	River mile at head of reach	Miles
S(IOR)	=	Vector of the heat or material balance obtained from computational element	Degrees Fahr. or Mg/L
TARGDO(I)	=	Minimum allowable target level for dissolved oxygen concentration in reach	Mg/L
T(IOR)	=	Temperature in computational element	Degrees Fahr.
TI(I)	=	Temperature of incremental inflow	Degrees Fahr.
TIME	=	Length of time over which a quality constituent has been routed	Hours
TINIT(I)	=	Temperature of incremental inflow	Degrees Fahr.
TITLE(I,J)	=	Alphanumeric program titles	-------
TOFDAY	=	Hour of day	Hours
TPRINT	=	Time counter to determine when to write intermediate summary	Hours
TRFACT(NWS)	=	Treatment plant efficiency (decimal fraction)	-------
TRLCD	=	Time counter to determine when to read Local Climatological Data	Hours
VEL(IOR)	=	Velocity in computational element	FPS
VHW(NHW)	=	Velocity at headwater source	FPS

VARIABLE NAME		DEFINITION	UNITS
WASTID(NWS,S)	=	Alphanumeric name of treatment plant, withdrawal, or point source	-------
WETBLB	=	Wet bulb temperature	Degrees Fahr.
WIND	=	Wind velocity	KNOTS
WSBOD(NWS)	=	5-day BOD of waste loading or point source	Mg/L
WSCONS(NWS,NC)	=	Concentration of conservative mineral in waste loading or point source	Mg/L
WSDO(NWS)	=	Concentration of dissolved oxygen in waste loading or point source	Mg/L
WSFLOW(NWS)	=	Discharge of waste loading, withdrawal, or point source	CFS
WSTEMP(NWS)	=	Temperature of waste loading or point source	Degrees Fahr.
Z(IOR)	=	Temporary storage vector	-------

VII. QUAL-I FLOW CHARTS

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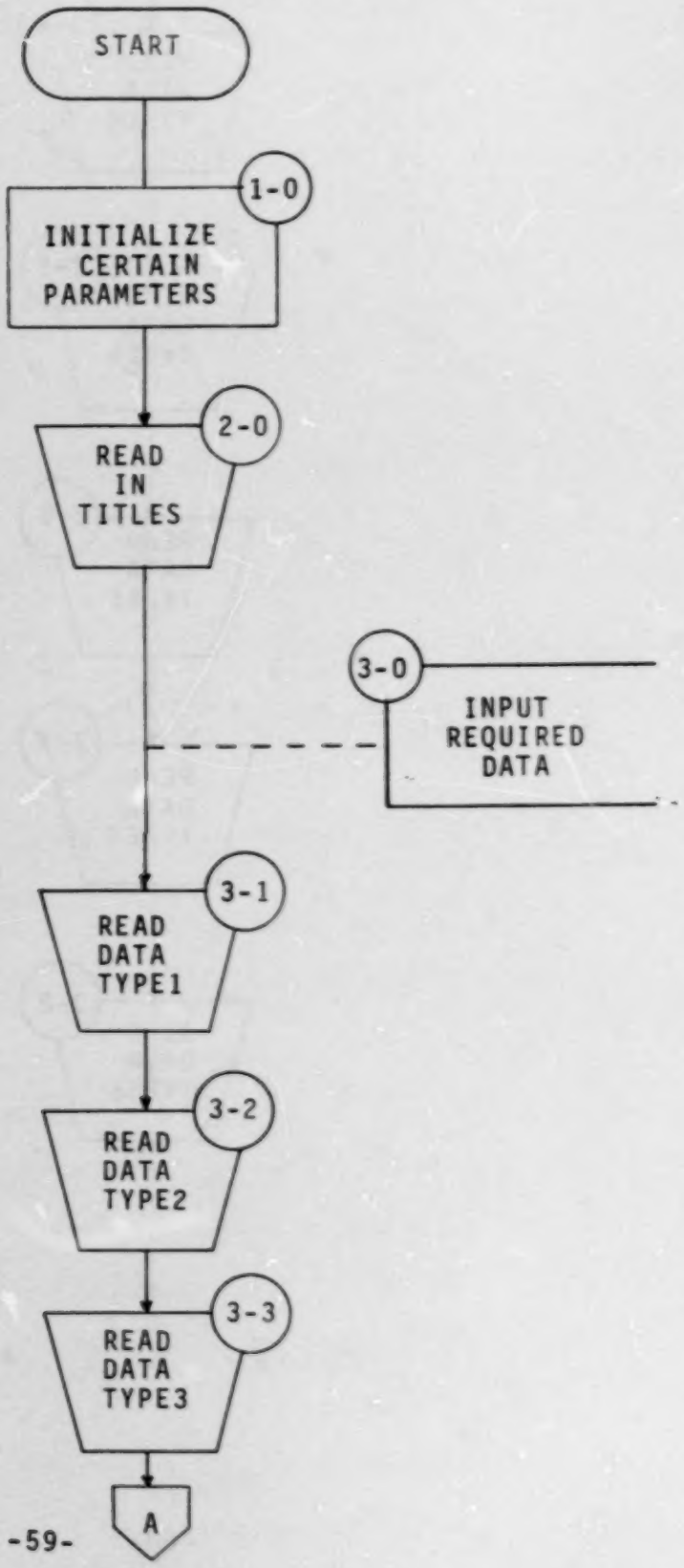
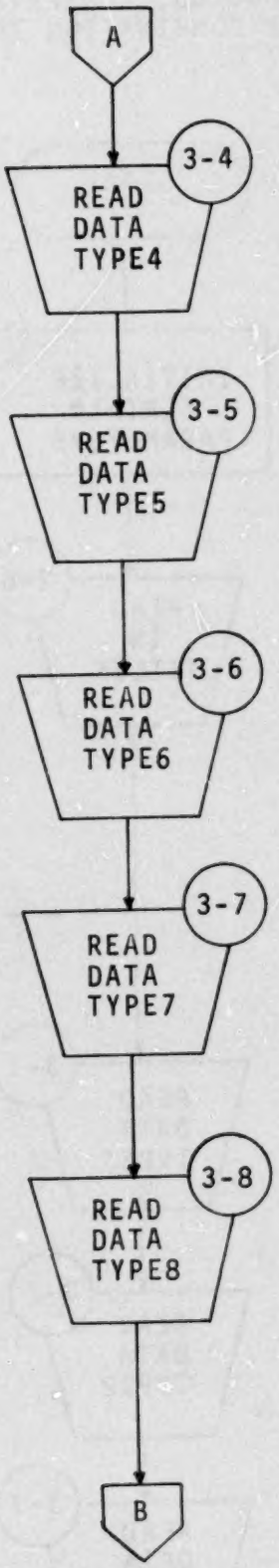
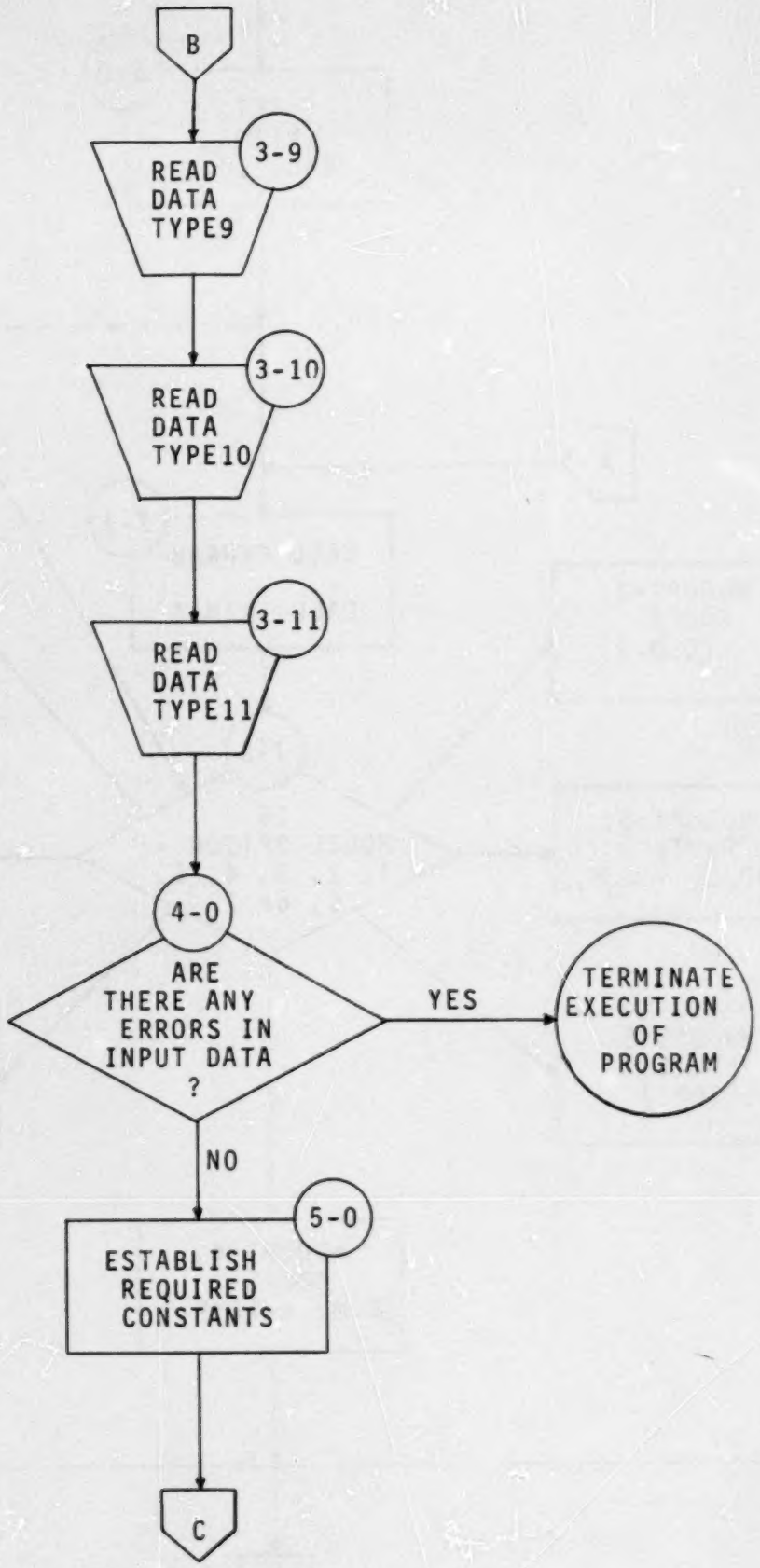
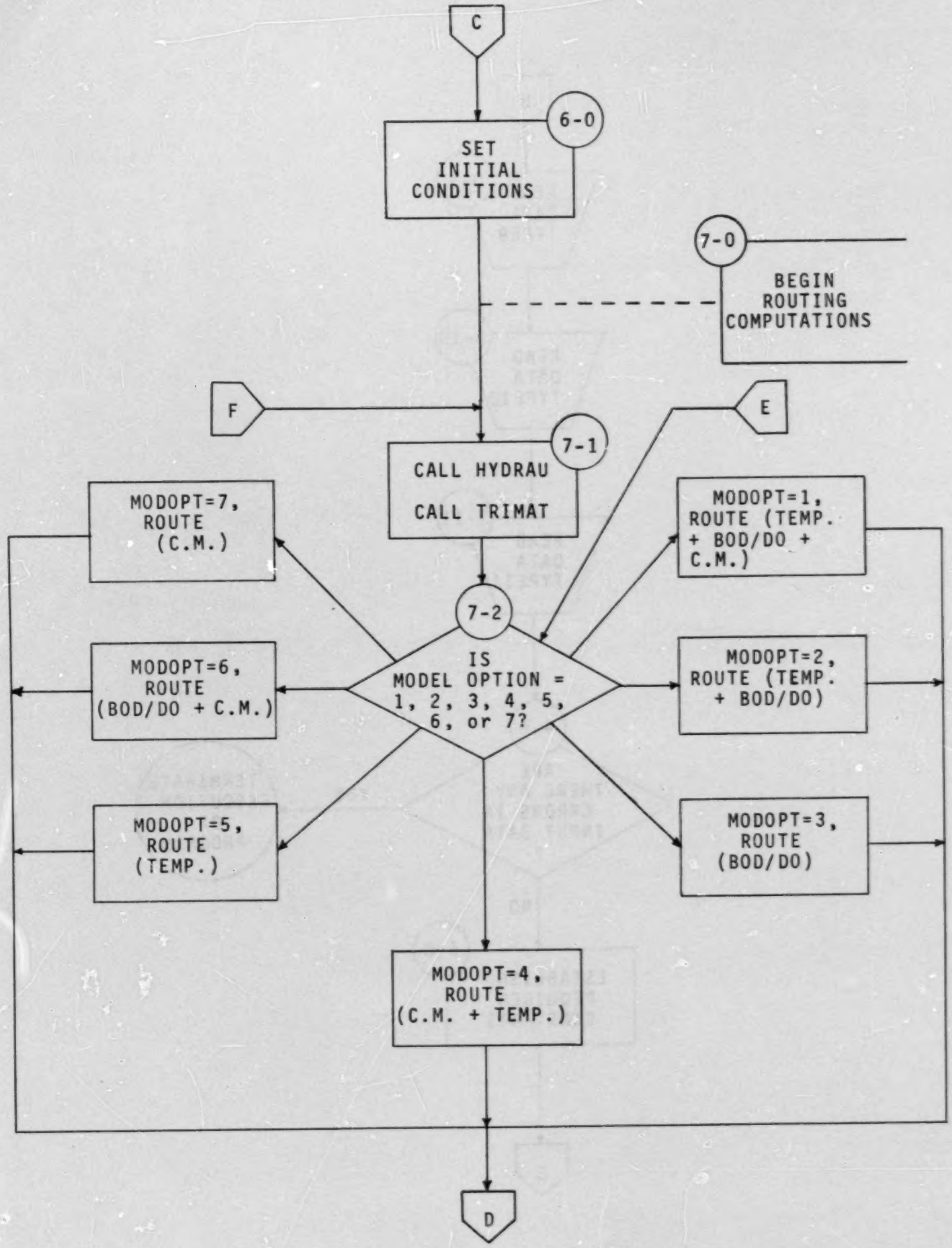
QUAL-I MAIN PROGRAM (QMODEL)

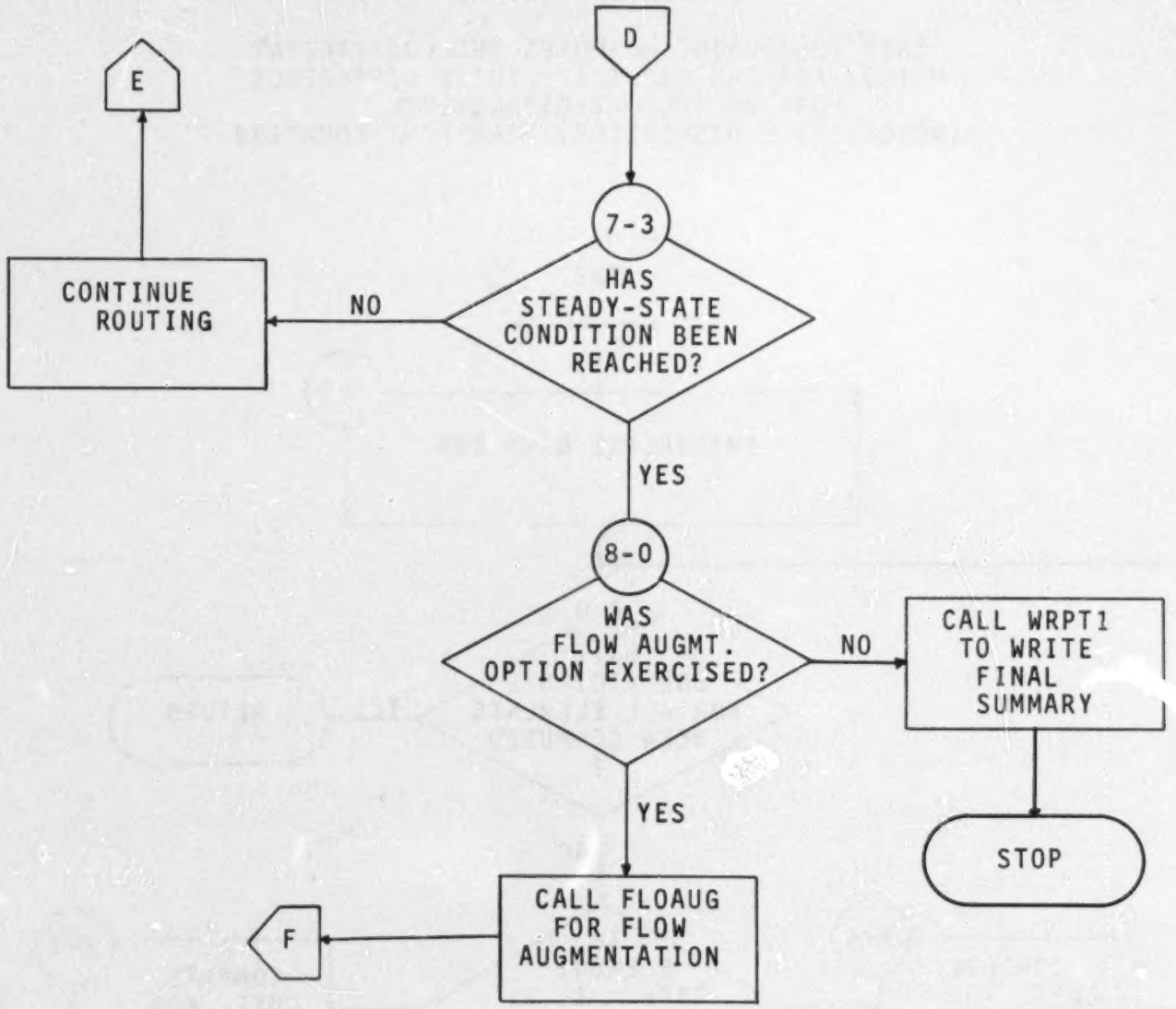
THIS IS THE EXECUTIVE PROGRAM
WHICH SELECTS THE ROUTING OPTION:
TEMPERATURE, BOD/DO, CONSERVATIVE MINEARL,
OR ANY COMBINATION THEREOF




A
3-4
READ
DATA
TYPE4
3-5
READ
DATA
TYPE5
3-6
READ
DATA
TYPE6
3-7
READ
DATA
TYPE7
3-8
READ
DATA
TYPE8
B

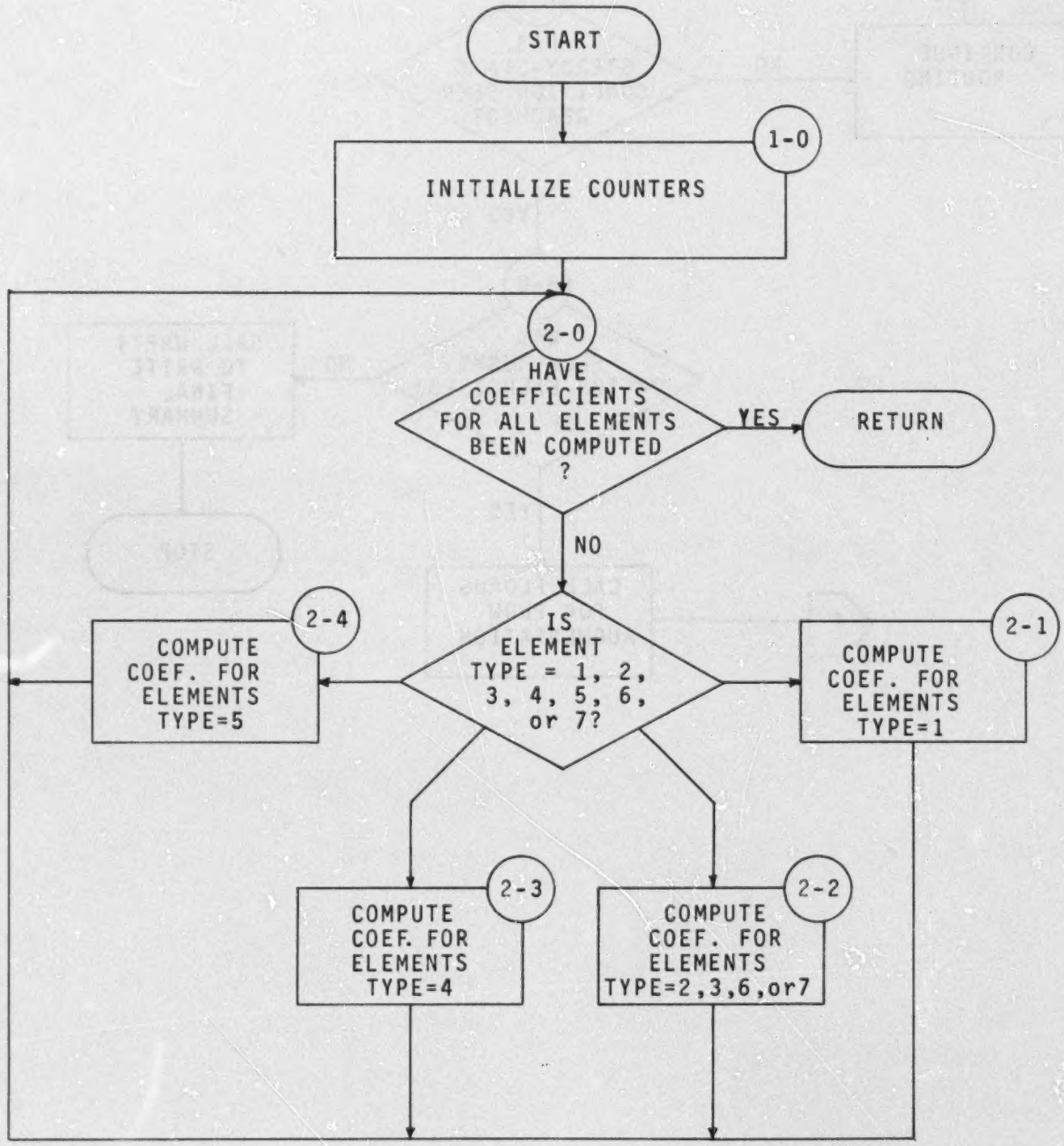

B
3-9
READ
DATA
TYPE9
3-10
READ
DATA
TYPE10
3-11
READ
DATA
TYPE11
4-0
ARE
THERE ANY
ERRORS IN
INPUT DATA
?
YES
TERMINATE
EXECUTION
OF
PROGRAM
NO
5-0
ESTABLISH
REQUIRED
CONSTANTS
C


C
6-0
SET INITIAL CONDITIONS
7-0
BEGIN ROUTING COMPUTATIONS
F
E
7-1
CALL HYDRAU
CALL TRIMAT
MODOPT=7, ROUTE (C.M.)
MODOPT=1, ROUTE (TEMP. + BOD/DO + C.M.)
7-2
IS MODEL OPTION = 1, 2, 3, 4, 5, 6, or 7?
MODOPT=6, ROUTE (BOD/DO + C.M.)
MODOPT=2, ROUTE (TEMP. + BOD/DO)
MODOPT=5, ROUTE (TEMP.)
MODOPT=3, ROUTE (BOD/DO)
MODOPT=4, ROUTE (C.M. + TEMP.)
D


D
E
7-3
HAS STEADY-STATE CONDITION BEEN REACHED?
NO
CONTINUE ROUTING
YES
8-0
WAS FLOW AUGMT. OPTION EXERCISED?
NO
CALL WRPT1 TO WRITE FINAL SUMMARY
STOP
YES
CALL FLOAUG FOR FLOW AUGMENTATION
F

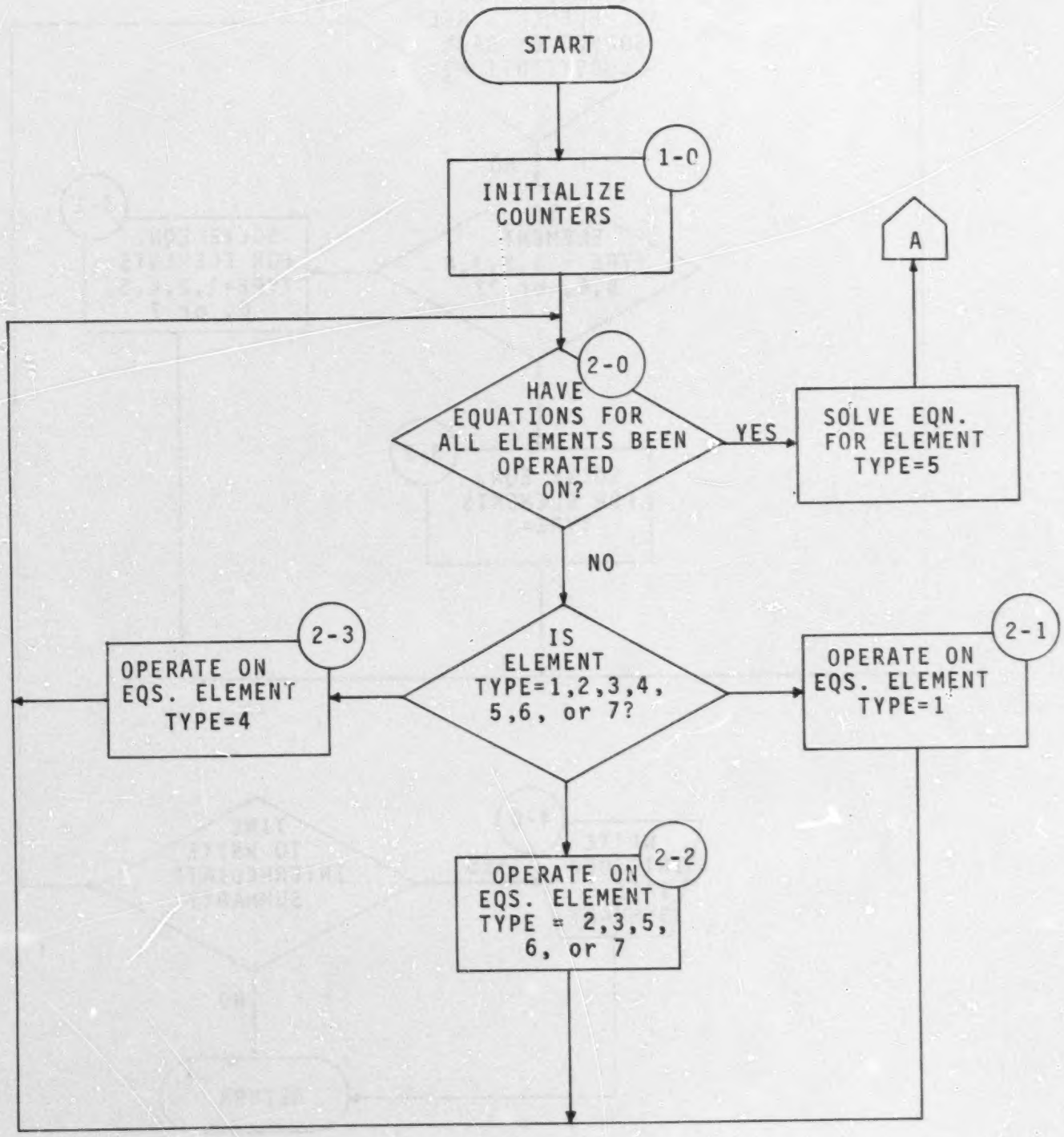
SUBROUTINE TRIMAT

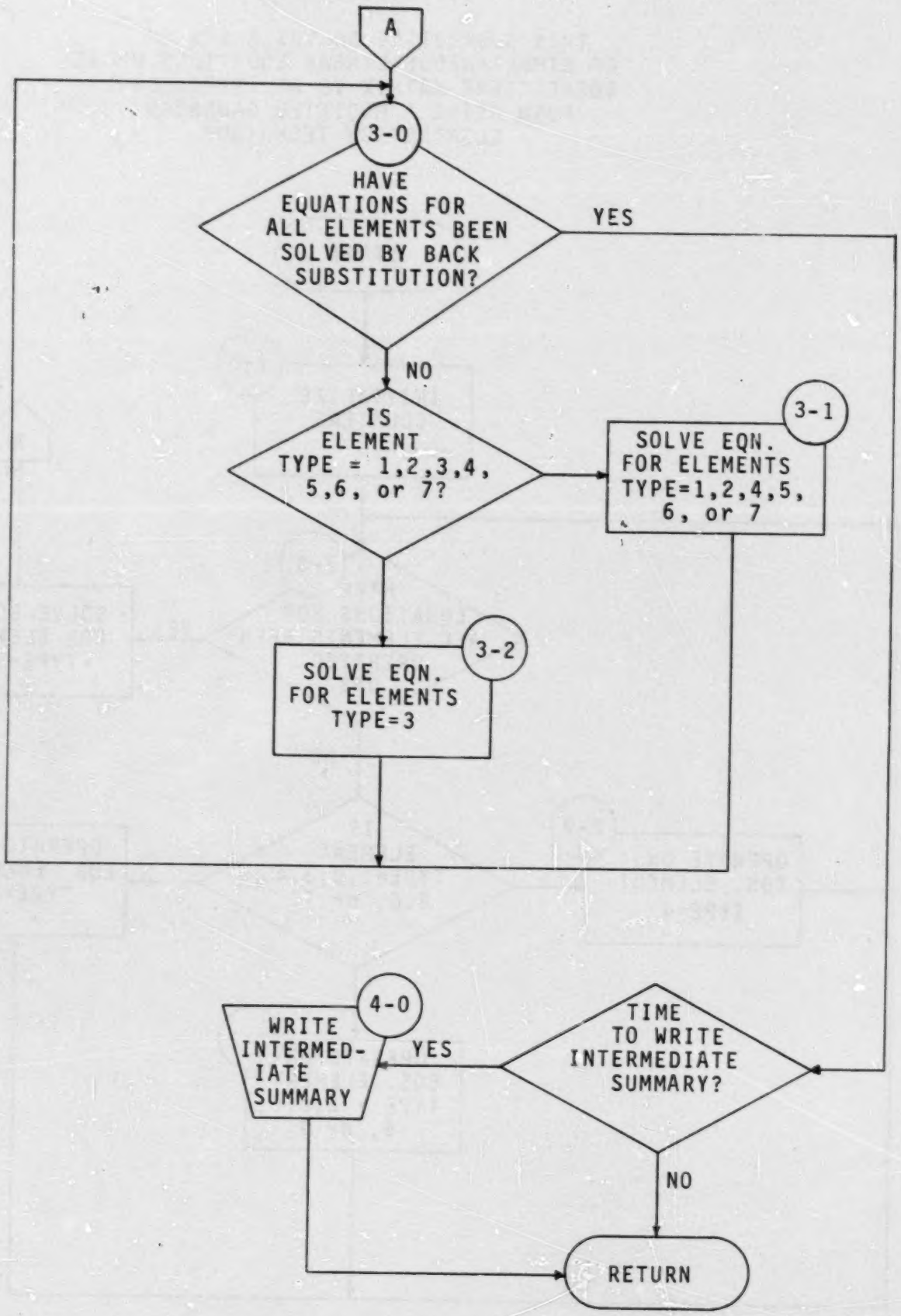
THIS SUBROUTINE COMPUTES THE COEFFICIENT MATRIX FOR THE IMPLICIT-FINITE-DIFFERENCE FORM OF THE ONE-DIMENSIONAL (ADVECTION + DISPERSION) TRANSPORT EQUATION



SUBROUTINE SOVMAT

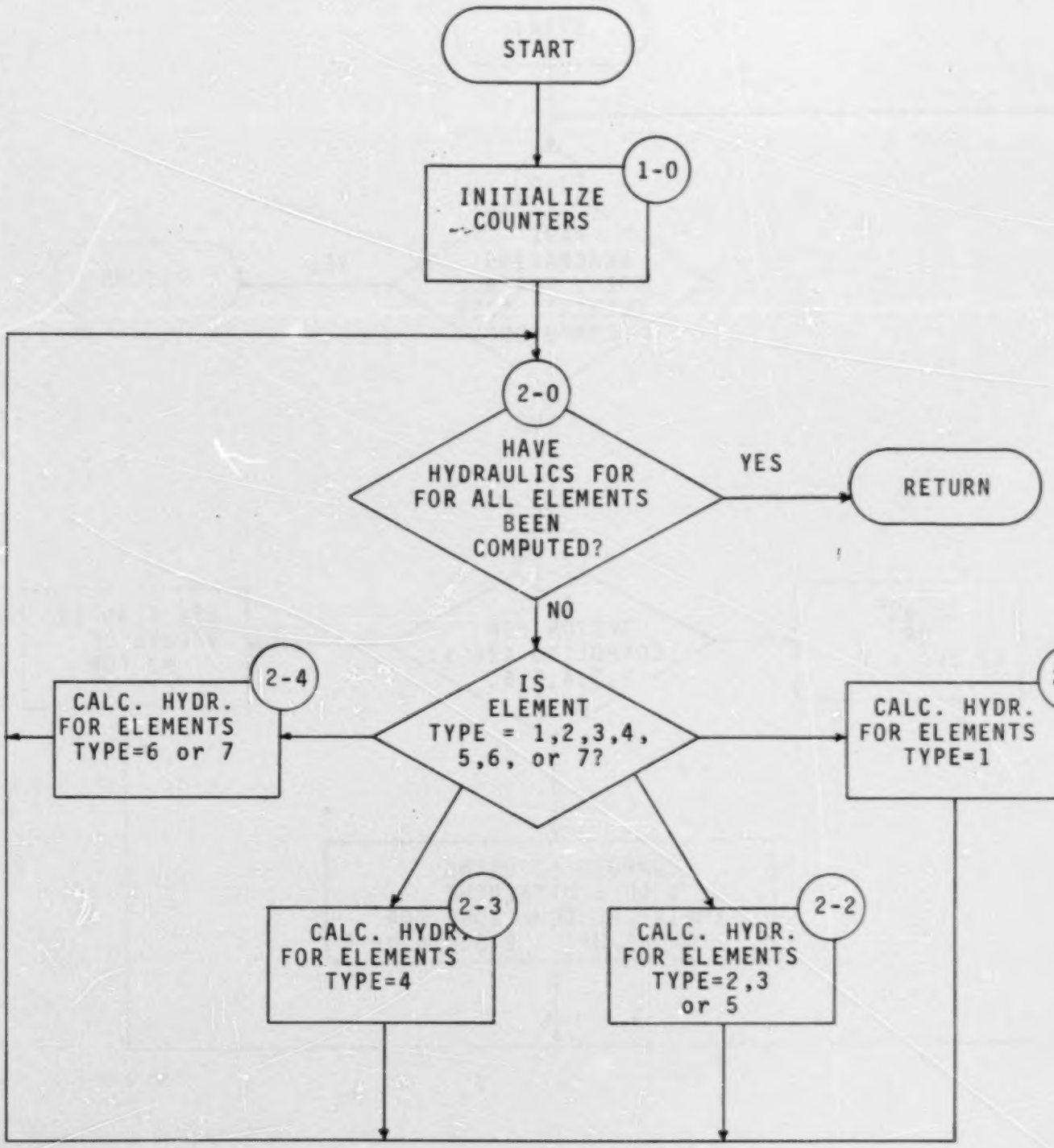
THIS SUBROUTINE SOLVES A SYSTEM
OF SIMULTANEOUS LINEAR EQUATIONS WHOSE
COEFFICIENT MATRIX IS OF TRIDIAGONAL
FORM USING A MODIFIED GAUSSIAN
ELIMINATION TECHNIQUE




A
3-0
HAVE EQUATIONS FOR ALL ELEMENTS BEEN SOLVED BY BACK SUBSTITUTION?
YES
NO
IS ELEMENT TYPE = 1,2,3,4, 5,6, or 7?
3-1
SOLVE EQN. FOR ELEMENTS TYPE=1,2,4,5, 6, or 7
3-2
SOLVE EQN. FOR ELEMENTS TYPE=3
4-0
WRITE INTERMED- IATE SUMMARY
YES
TIME TO WRITE INTERMEDIATE SUMMARY?
NO
RETURN

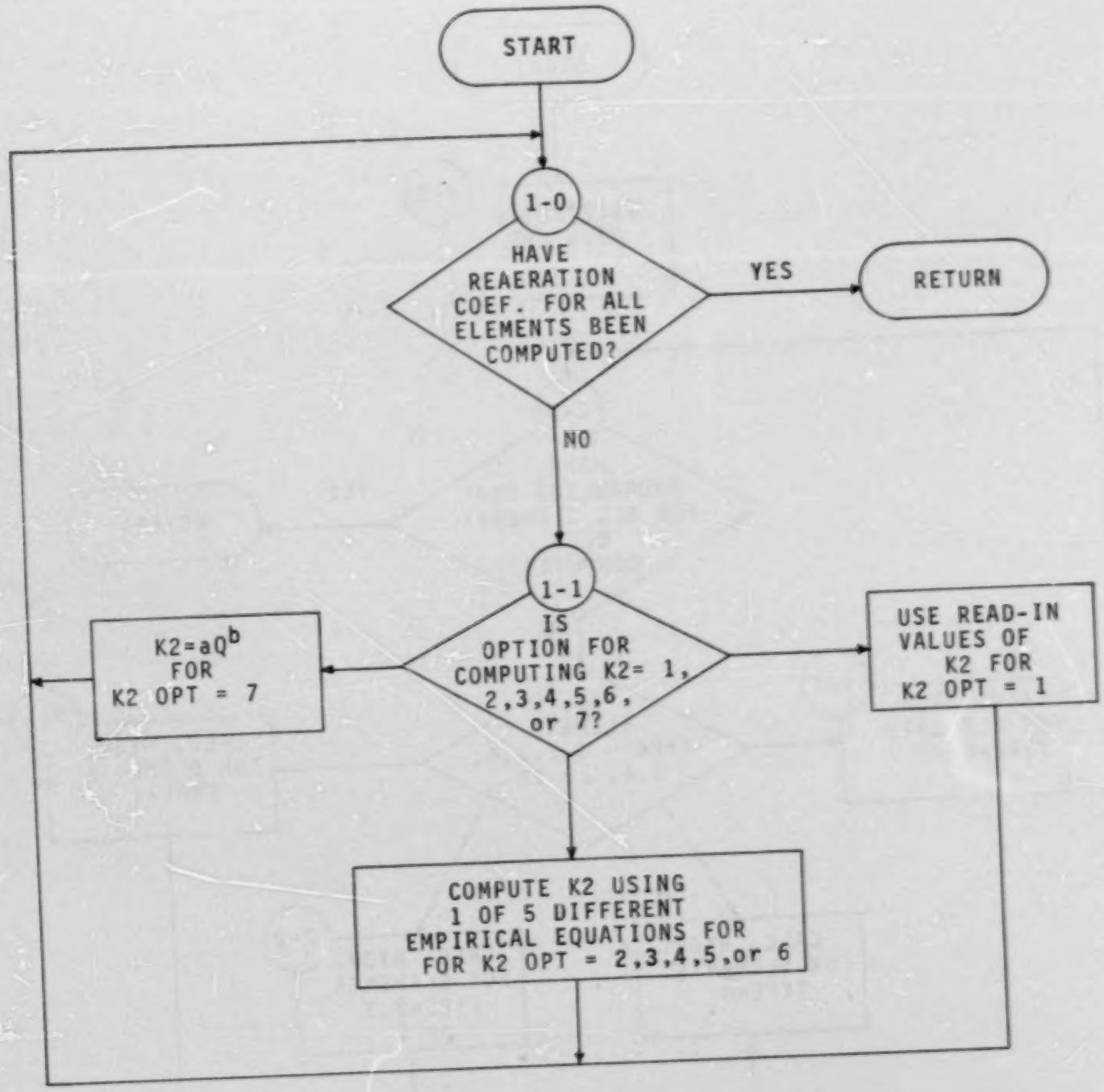
SUBROUTINE HYDRAU

THIS SUBROUTINE PERFORMS A HYDROLOGIC BALANCE
ON THE SYSTEM BASED ON CONTINUITY;
IT COMPUTES THE FLOW, VELOCITY, VOLUME,
DEPTH, AND DISPERSION COEFFICIENTS
FOR EVERY COMPUTATIONAL ELEMENT IN THE SYSTEM



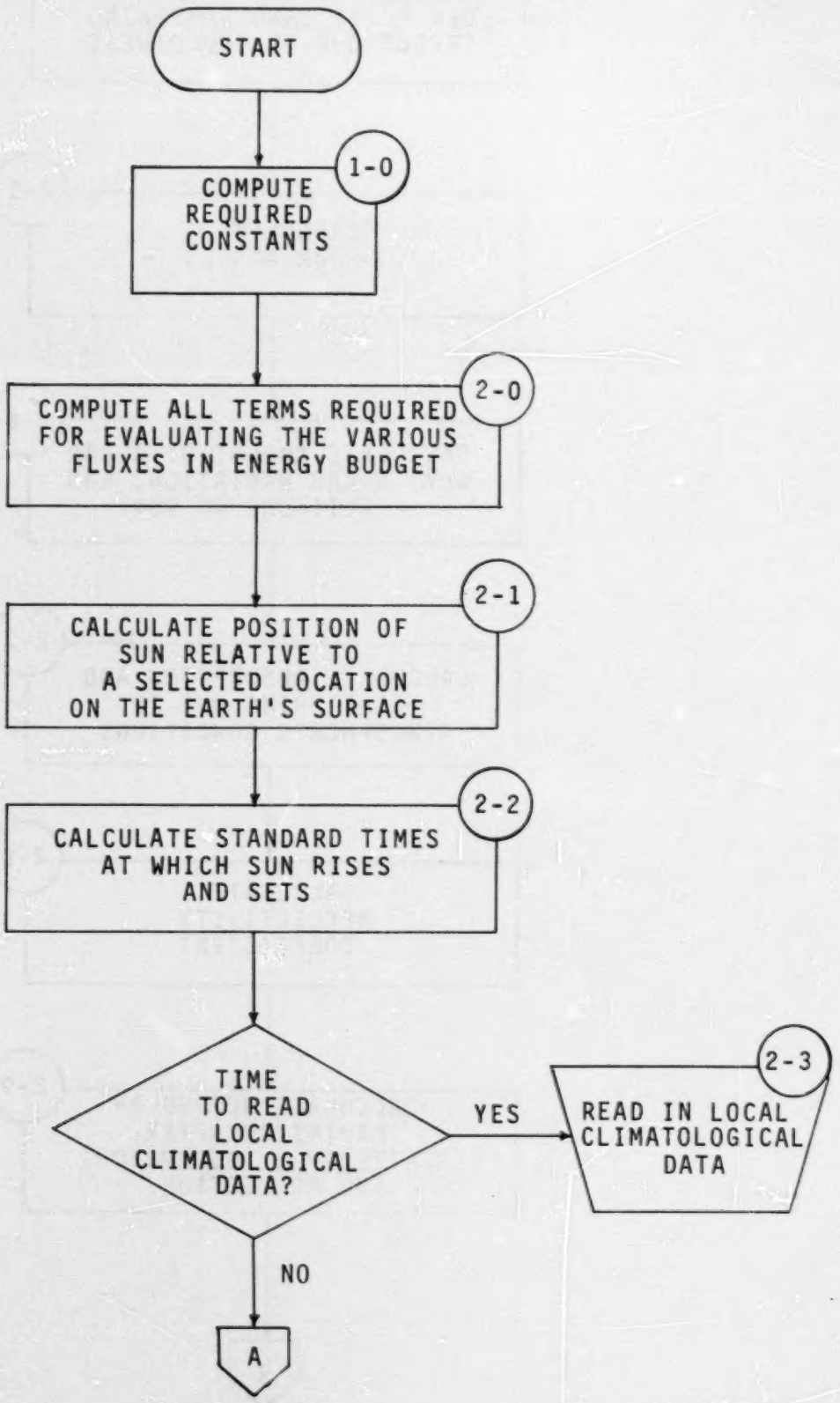
SUBROUTINE REAERC

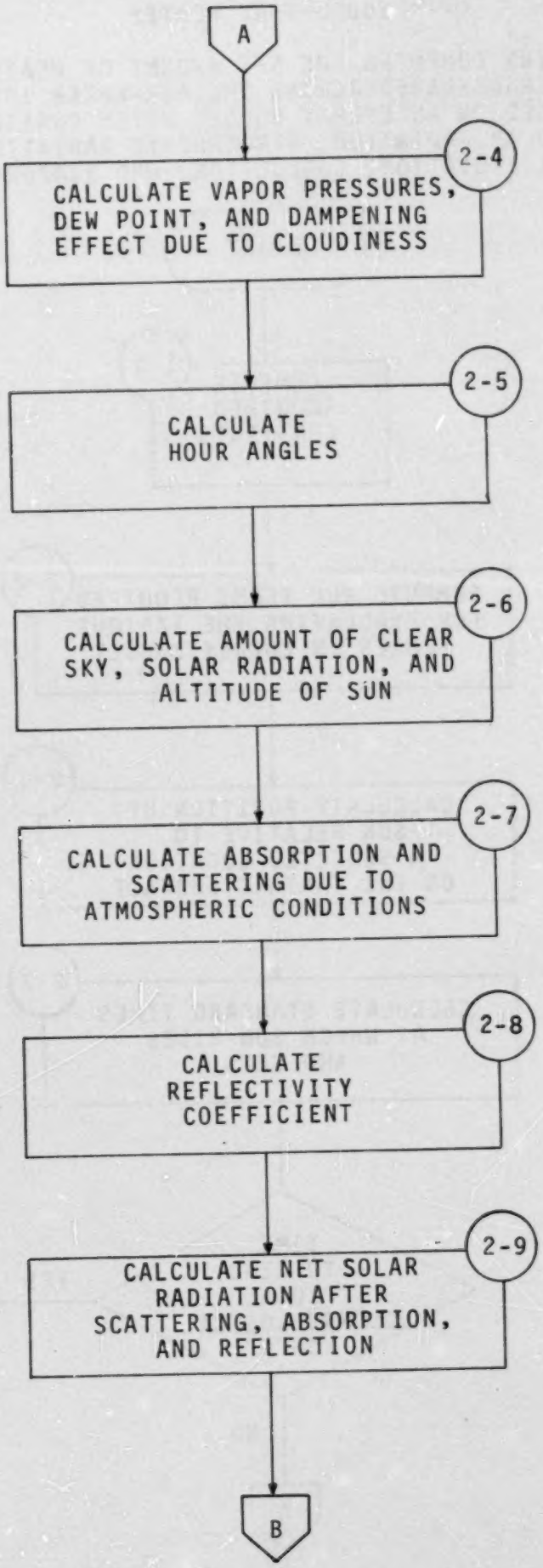
THIS SUBROUTINE CAN EITHER USE READ-IN VALUES
FOR THE REAERATION COEFFICIENTS,
COMPUTE THEM USING A SELECTED EMPIRICAL EQUATION,
OR COMPUTE THEM BASED ON FLOW

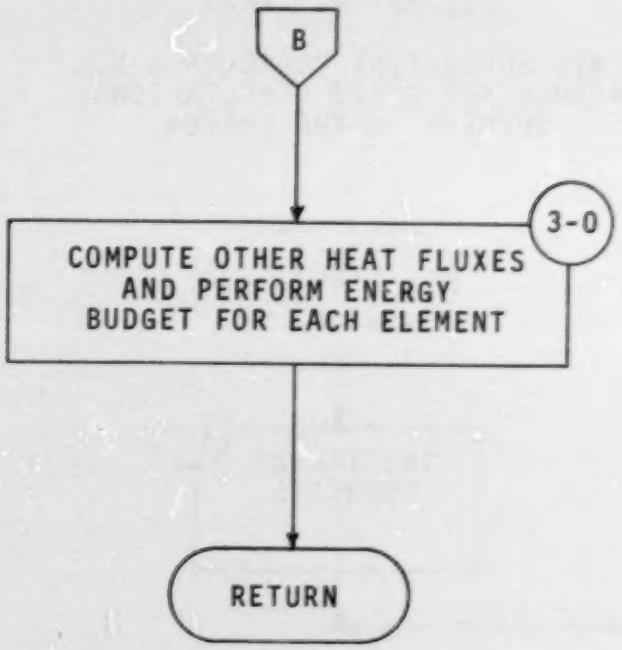


SUBROUTINE HEATEX

THIS SUBROUTINE COMPUTES THE NET AMOUNT OF HEAT RADIATION FLUX
BEING TRANSFERRED ACROSS THE AIR-WATER INTERFACE
BASED ON AN ENERGY BUDGET WHICH CONSIDERS
SOLAR RADIATION, ATMOSPHERIC RADIATION,
BACK RADIATION, CONDUCTION, AND EVAPORATION

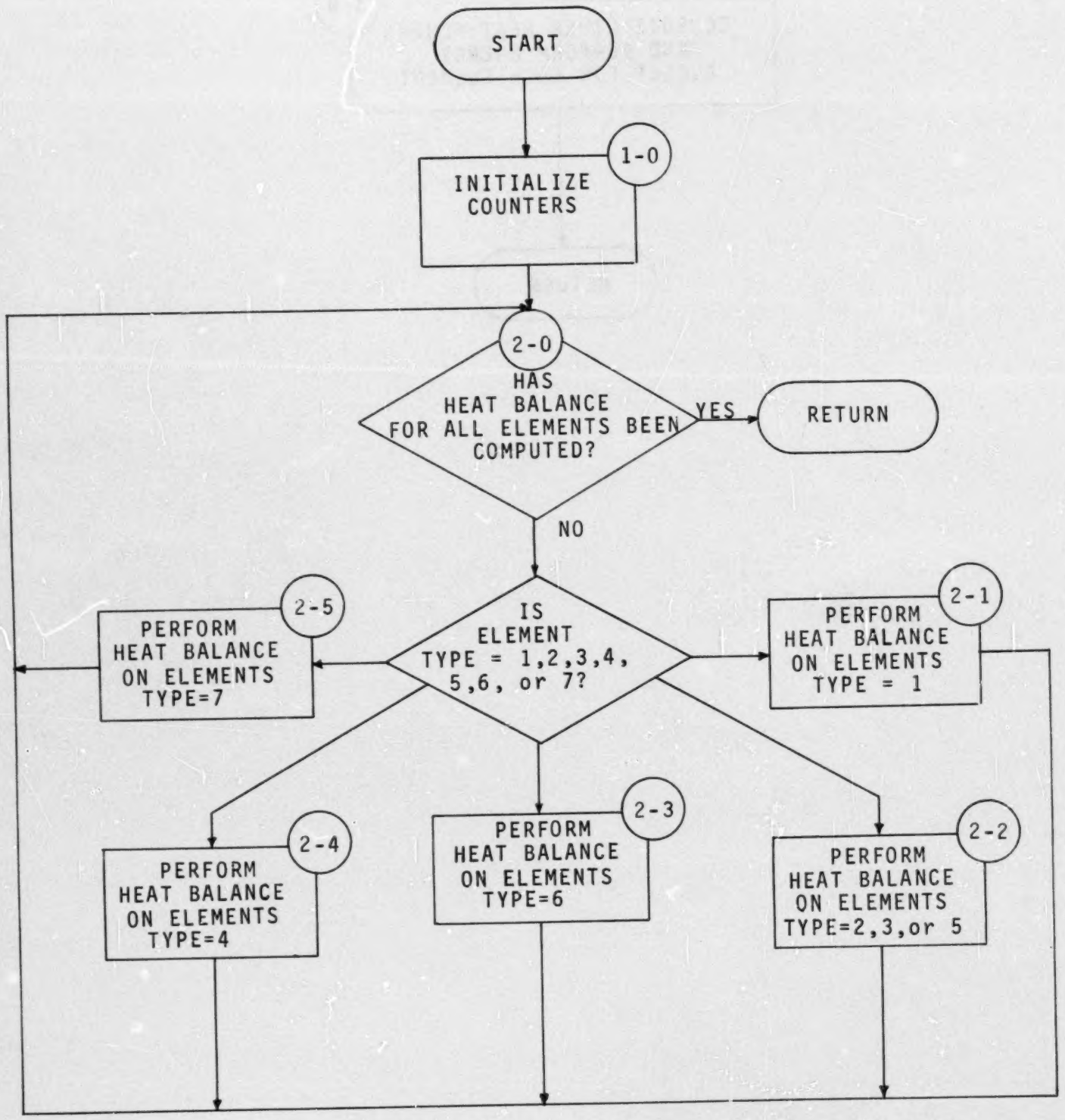



A
2-4
CALCULATE VAPOR PRESSURES, DEW POINT, AND DAMPENING EFFECT DUE TO CLOUDINESS
2-5
CALCULATE HOUR ANGLES
2-6
CALCULATE AMOUNT OF CLEAR SKY, SOLAR RADIATION, AND ALTITUDE OF SUN
2-7
CALCULATE ABSORPTION AND SCATTERING DUE TO ATMOSPHERIC CONDITIONS
2-8
CALCULATE REFLECTIVITY COEFFICIENT
2-9
CALCULATE NET SOLAR RADIATION AFTER SCATTERING, ABSORPTION, AND REFLECTION
B


B
3-0
COMPUTE OTHER HEAT FLUXES AND PERFORM ENERGY BUDGET FOR EACH ELEMENT
RETURN

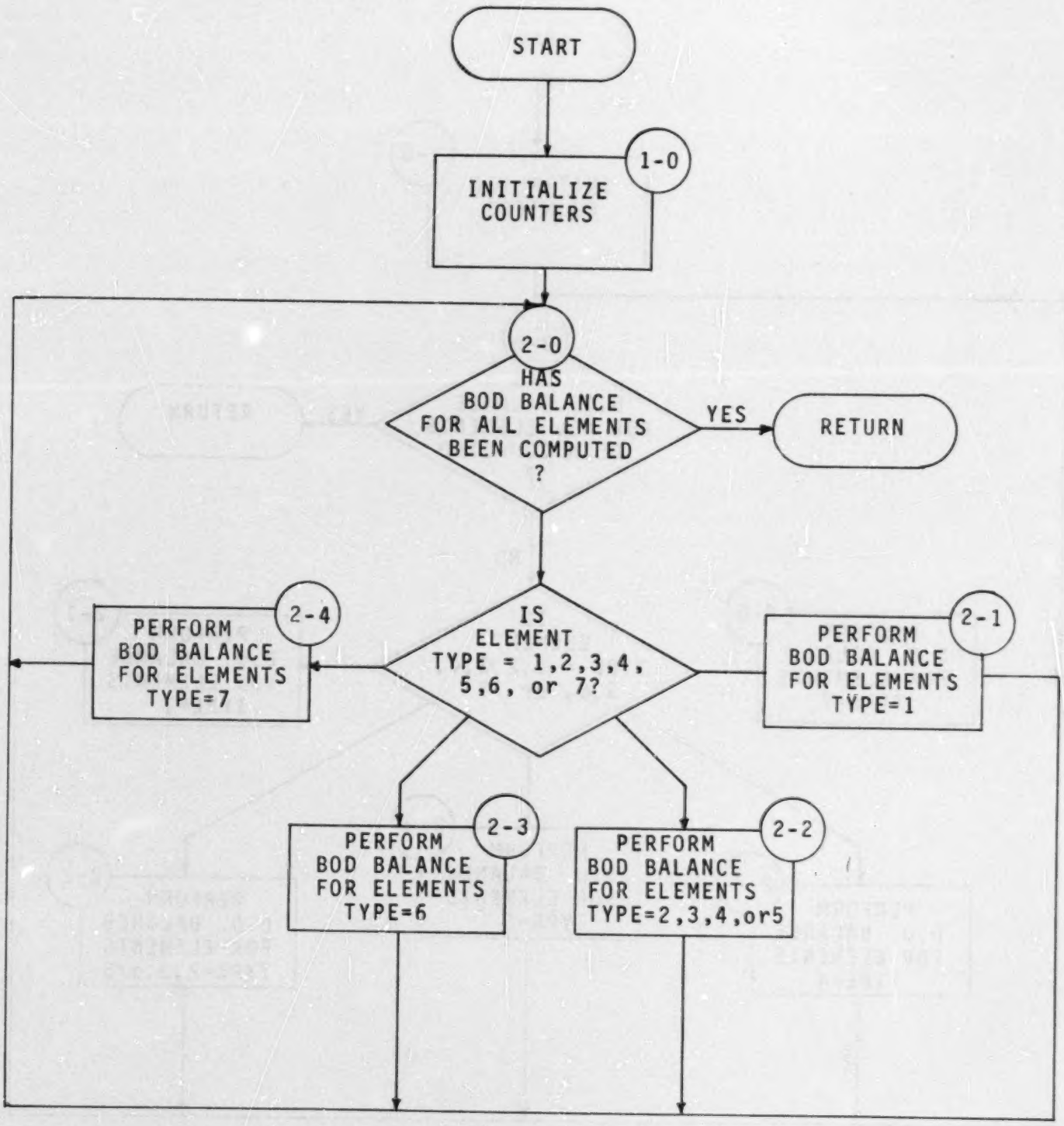
SUBROUTINE TEMPS

THIS SUBROUTINE PERFORMS A HEAT BALANCE FOR EVERY COMPUTATIONAL ELEMENT IN THE SYSTEM



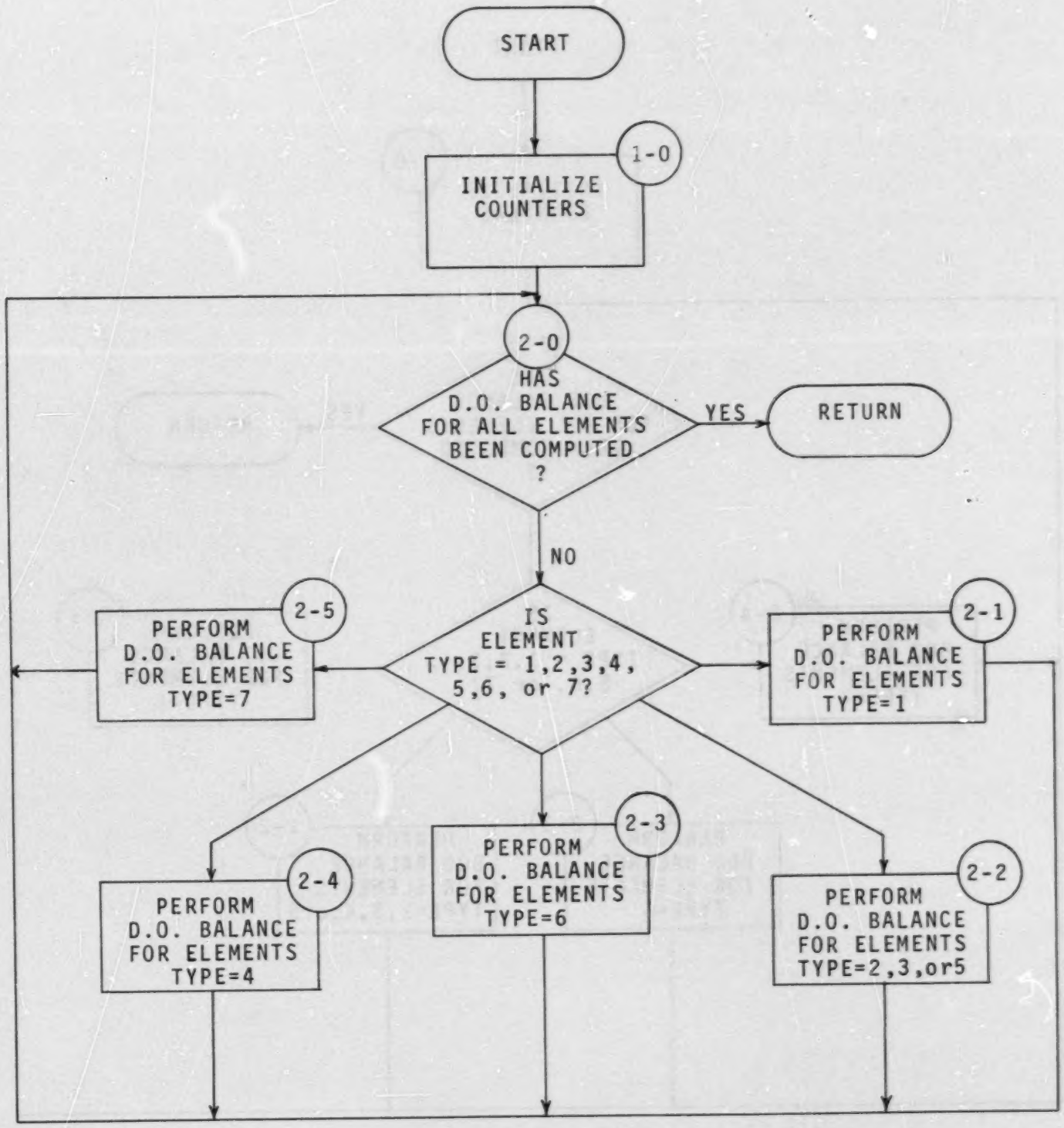
SUBROUTINE BODS

THIS SUBROUTINE PERFORMS A
BIOCHEMICAL OXYGEN DEMAND BALANCE
FOR EVERY COMPUTATIONAL ELEMENT IN THE SYSTEM



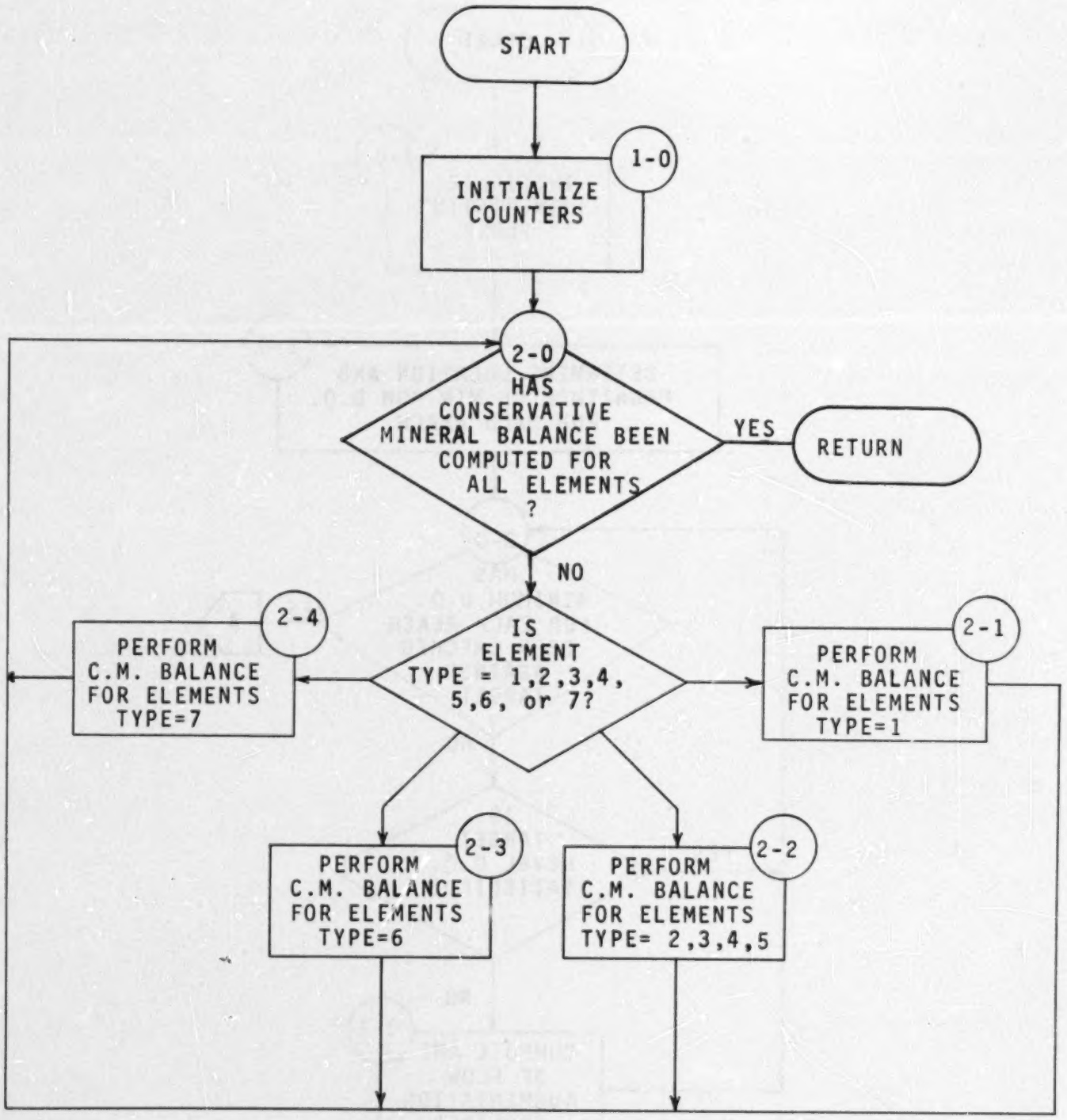
SUBROUTINE DOS

THIS SUBROUTINE PERFORMS A
DISSOLVED OXYGEN BALANCE FOR
EVERY COMPUTATIONAL ELEMENT IN THE SYSTEM



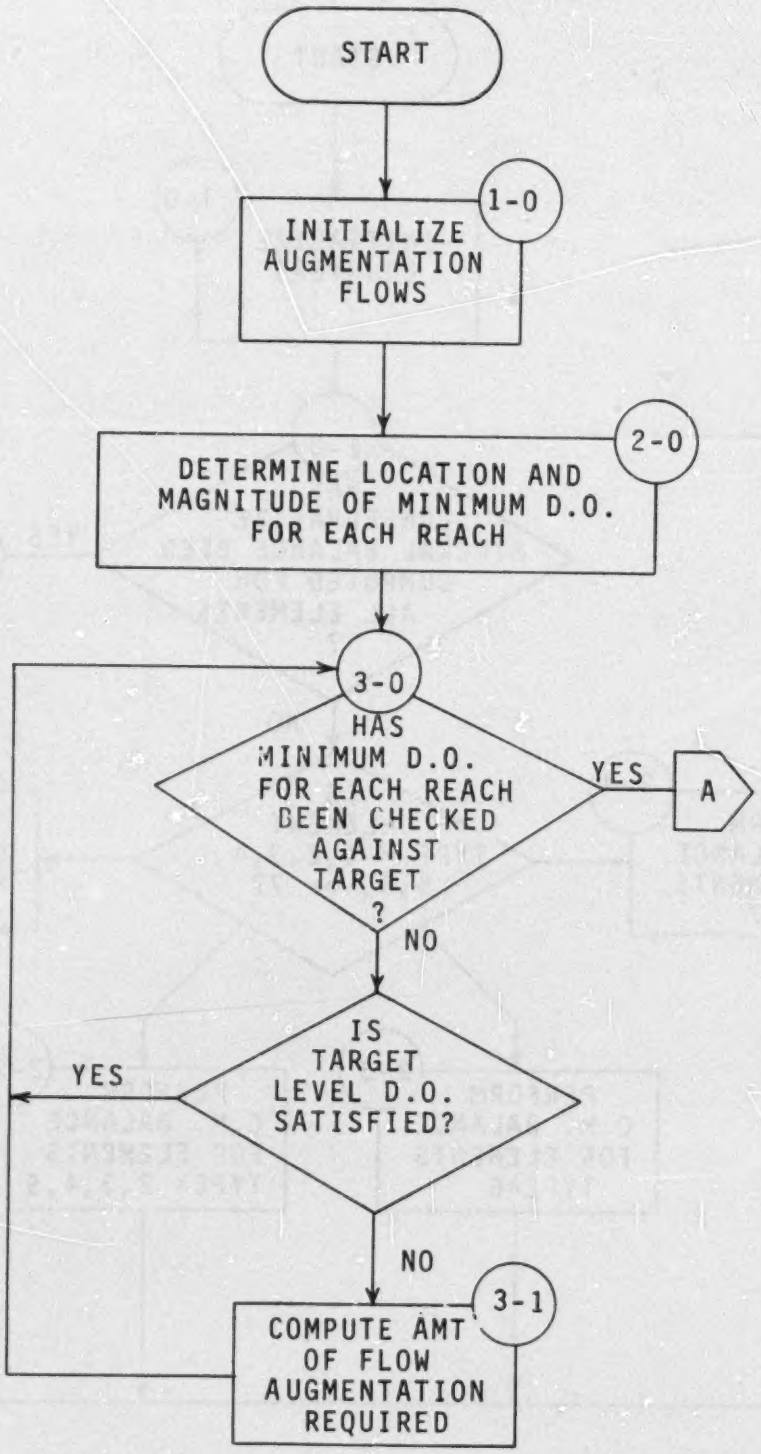
SUBROUTINE CONSVT

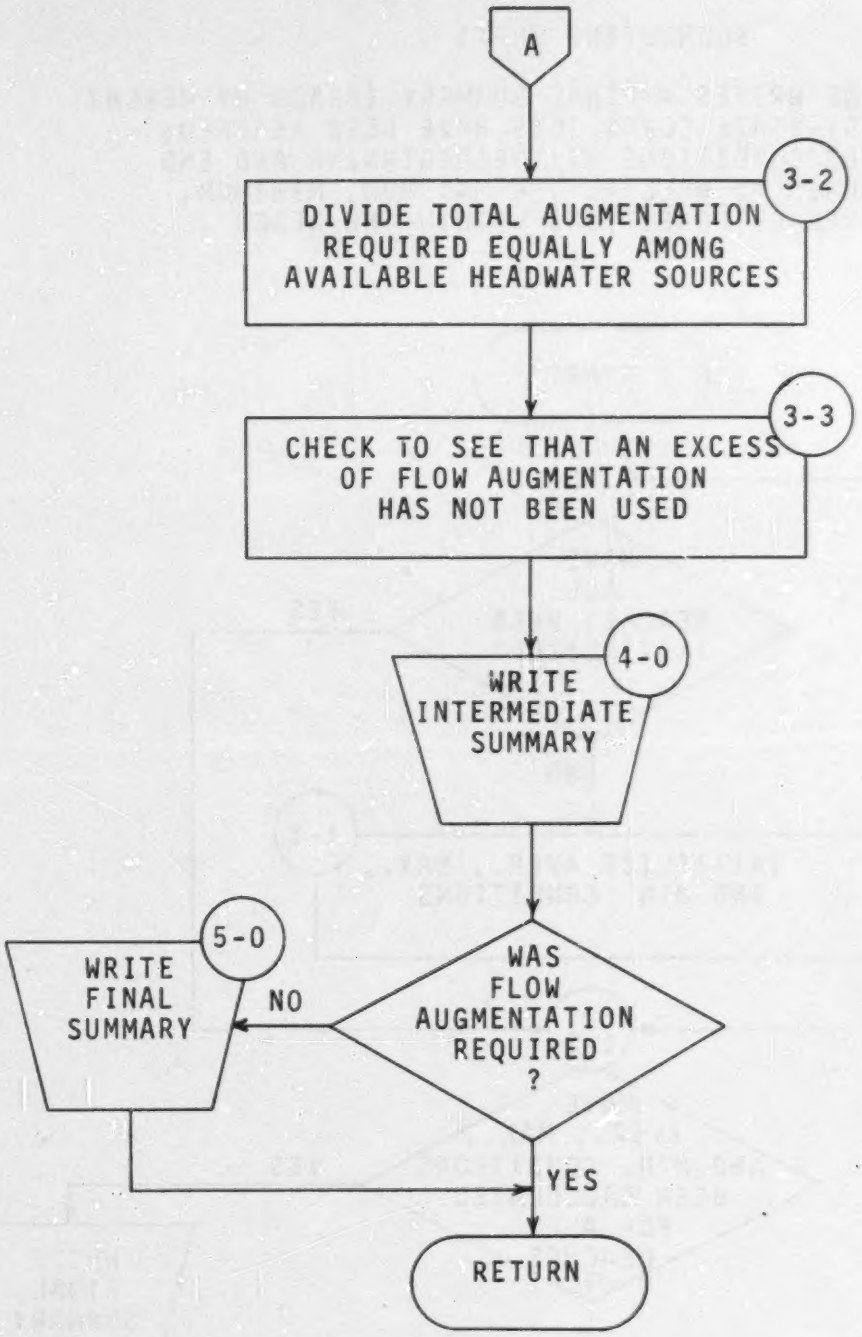
THIS SUBROUTINE PERFORMS A
CONSERVATIVE MINERAL BALANCE FOR
EVERY COMPUTATIONAL ELEMENT IN THE SYSTEM



SUBROUTINE FLOAUG

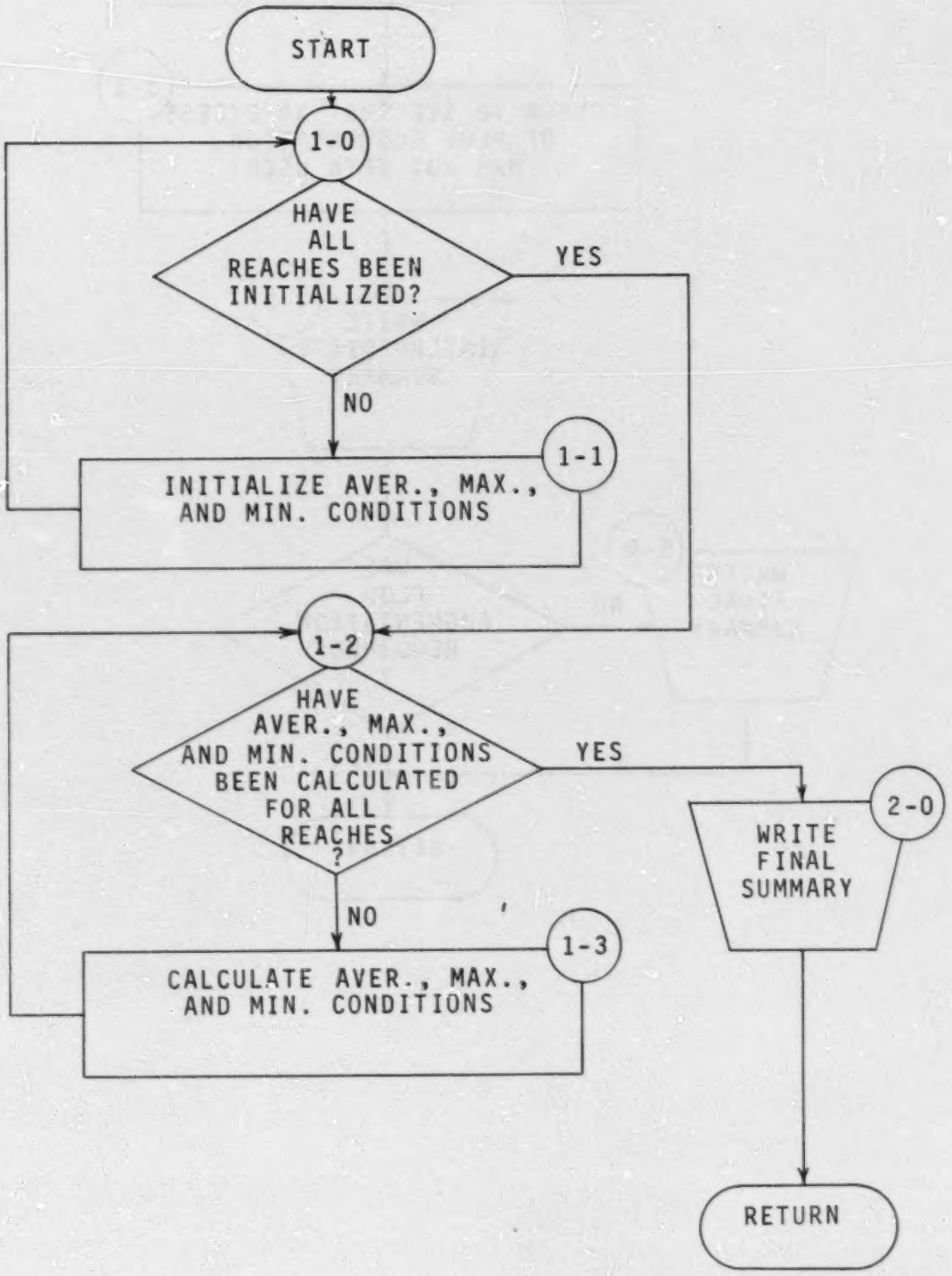
THIS SUBROUTINE DETERMINES MINIMUM D.O. LEVELS; IF THESE DO NOT SATISFY PRESELECTED TARGET LEVELS FLOW AUGMENTATION IS IMPLEMENTED

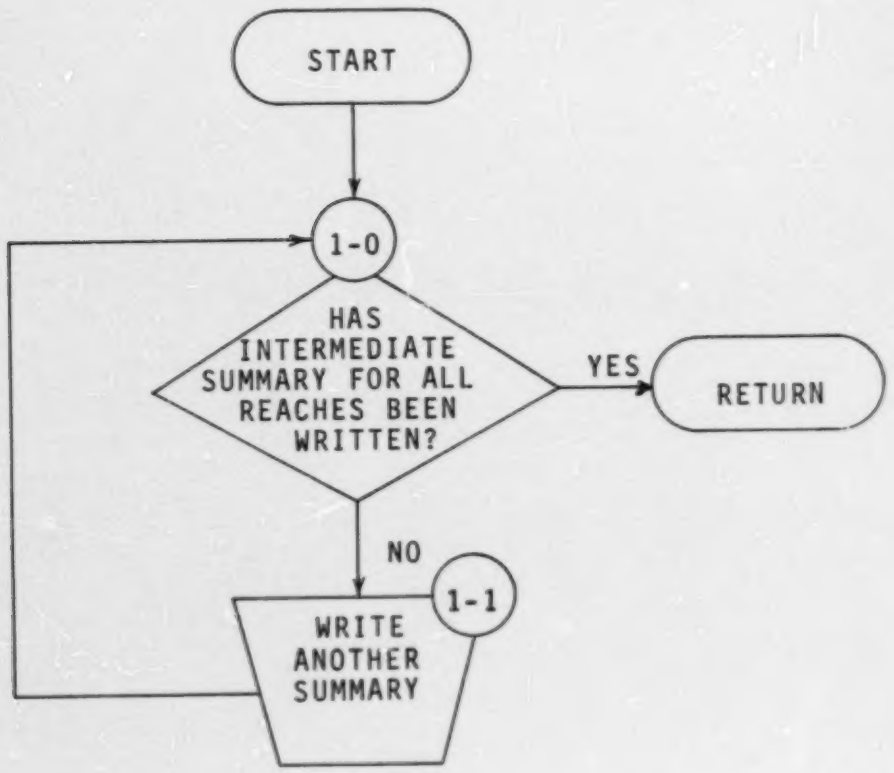



A
3-2
DIVIDE TOTAL AUGMENTATION REQUIRED EQUALLY AMONG AVAILABLE HEADWATER SOURCES
3-3
CHECK TO SEE THAT AN EXCESS OF FLOW AUGMENTATION HAS NOT BEEN USED
4-0
WRITE INTERMEDIATE SUMMARY
WAS FLOW AUGMENTATION REQUIRED ?
NO
5-0
WRITE FINAL SUMMARY
YES
RETURN

SUBROUTINE WRPT1

THIS SUBROUTINE WRITES A FINAL SUMMARY (REACH BY REACH)
AFTER STEADY-STATE CONDITIONS HAVE BEEN REACHED;
IT SUMMARIZES CONDITIONS AT THE BEGINNING AND END
OF THE REACH AS WELL AS THE MAXIMUM, MINIMUM,
AND AVERAGE CONDITIONS WITHIN THE REACH



SUBROUTINE WRPT2

THIS SUBROUTINE WRITES AN INTERMEDIATE SUMMARY
ELEMENT BY ELEMENT; THE SUMMARY
CAN BE OBTAINED AT PRE-SELECTED TIME INTERVALS